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ARAŞTIRMA MAKALESİ **RESEARCH ARTICLE**

A detailed experimental knowledge on differentiation of nutritional quality depending on the phenological stages of native cool season grasses and satisfying the daily maintenance requirements of livestock

Doğal serin iklim buğdaygil yembitkilerinin bitki gelişme dönemlerine bağlı yem kalitesi değişimi ve çiftlik hayvanlarının günlük ihtiyacını karşılayabilme yetenekleri

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Ö Z E T / A B S T R A C T

Aims: For a proper range management and livestock feeding operations need to detailed chemical analyses and knowledge on pasture composition.
Methods and Results: Seven native cool-season grasses that are *Festuca arundinaceae* L., *Brachypodium pinnatum* (L.) Beauv., *Phleum pretense* L., *Dactylis glomerata* L., *Bromus inermis* Leyss., *Lolium perenne* L. and *Hordeum bulbosum* L. were evaluated for their nutritive value at five different phenological stages. The chemical composition, quality and therefore their feeding value so the animal performance are directly under control of the stage of plant phenology. Stage of plant maturity decreases dry matter digestibility, dry matter intake and protein content, but increases in lignocellulosic structure with the advance phenology of the whole investigated perennial species.
Conclusions: The species which have thickand longer leaves, and higher leaf/stem ratio determined as the more digestible, and also the metabolizable energy of the fast growing ones was considerably higher. The vast majority of the minerals' concentration was distinctly reduced at stem elongation to flowering and then increased remarkably from that point to developing seed stalks. The fast growing species accumulated the minerals more. Grass Tetany risk (K/(Ca+Mg)) of the investigated species increased remarkably at head emergence and flowering stage. Most of the species were detected within the boundaries of the recommended Ca/P ratio for diet.
Significance and Impact of the Study: The native pastures seem to satisfy the daily maintenance requirements of most livestock in respect to most minerals without any supplementation via correct timing for feeding.

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INTRODUCTION

Grazing lands and pastures are important components in agricultural production systems. Ruminant production throughout the world is based on forages; with grassland feeds being predominant that is one of the cheaper sources of feed. And the ration in dry matter should be arranged depending on the stage of lactation. Forages are required also for stimulation to rumination and salivation which are maintain the healthy rumen environment, improvement of the efficiency of rumen bacterial growth, elimination of the milk fat depression in dairy cattle (Schroeder, 1996). The major determinant of grazing progress for livestock is productivity and the quality. The quantity of commodities and the use factor of fodder represent the quality. In other words for obtaining the desired animal response quality is the key factor. However, forage quality and nutritional needs vary within forage crops and animal species. Ball et al. (2001) denoted that the palatability, intake, digestibility, nutrient content, anti-quality factors (tannins, nitrates, cyanoglycosides, estrogens, mycotoxins etc.) are distinctive marks of forage quality or nutritive value. Whereas the minerals that correlated with those should not be overlooked for a proper ration and higher live weight gain. The minerals are key of the many metabolic reaction most of the time. Sometimes they are starter and mostly stimulator. That’s why the forage quality is formed by the accumulation rate of the minerals in plant tissues one way or another. This metabolic pathway is important also for the grazing animals’ health. The functioning of the organisms disrupted, systems deteriorate and the animals become susceptible to illness, as a result loss of appetite and development abnormalities may occur in mineral deficiency or oversupply. Since some of the trace minerals are the components of metalloenzymes and enzyme cofactors or hormones of the endocrine system of the animals (NRC, 2001). No producer wants encountering with those undesirable situations that reduce animal performance and productivity. So the diet must supply with minerals at the maintenance requirement. This point is generally higher than the forage contained. That’s why the deficient amount should be added to diet at the level of maintenance requirement from the other feedstuffs listed by NRC (2001). According to organic livestock standards mineral supplementation in diet should be rendered unnecessary via proper agricultural management (Renner, 2001). So the native resources come into prominence. It is difficult to monitoring and control the mineral intake in pasture based livestock systems. The information getting more vital if the pasture is native. So, producing desired quality forage for an animal type or any specific condition requires knowing the factors that affect forage quality. Many factors such as species, phenological stages at harvest or grazing, ecological conditions, management practices, harvesting or storage methods are affective on it (Kappel et al., 1983; Stone, 1994; Greene, 1997). Knowledge on plant characteristics, phenology and their nutritive value at different growth stage could help the range managers to design a proper management that organize stocking rate and grazing period (Arzani et al., 2004). Moreover analyzing forages for quality could guide the manager whether it is adequate or need supplementation for proper ration. The strategic feeding at selected times is important for balancing the rations and figuring out the lowest costs. That’s why these kinds of studies are important key from the standpoint of achieving higher animal performance without damage to native vegetation for many years.

The study presented in this paper discusses the variations of nutritional values and chemical composition of some important native pasture grasses at different phenological stages. It offers comparative analyses on feeding values of fast and slow growing, leafy and stemmy etc. species also.

MATERIALS and METHODS

Species were selected and clipped within the flora of the unfertilized native pastures of Amik Plain located at the east Mediterranean costal region of Turkey. The site was between 35° 47′-36° 24′ E; 35° 48′-36° 37′ N at 85 m. average altitude. The climate is a Mediterranean-type characterized by hot and dry summers and mild winters during which about 67% of the average annual precipitation of 890 mm occurs. Average annual temperature reaches a maximum of 28.8°C in the August and a minimum of 8.8°C in the January, with an average annual temperature of 12.4°C (Celiktas et al., 2017). The soil parent materials in Amik Plain consist of mostly alluviums formed by Orontes (Asi), Afrin and Karasu rivers. The majority of the soils in Amik Plain were determined Vertisol (34%), Entisol (25%) and Inceptisol (20%) and the soil organic matter was almost poor (Kılıç, 2004). The perennial cool-season C3 grasses evaluated of were; Tall fescue (*Festuca arundinaceae* L.), Tor-grass (*Brachypodium pinnatum* (L.) Beauv.), Timothy (*Phleum pratense* L.), Orchard grass (*Dactylis glomerata* L.), Smooth brome (*Bromus inermis* Leyss.), Perennial Ryegrass (*Lolium perenne* L.) and Bulbous barley (*Hordeum bulbosum* L.). The plants were harvested at five different phenological stages that were adapted from Cogswell and Kamstra (1976), such as follows vegetative (VEG), stem elongation (STE), head emergence and flowering (HEF), developing seed stalks (DSS) and seed ripe (SER). Harvested aboveground materials from 3 individual clone of each species at the stages of phenology described above were washed with continuously flowing tap water and rinsed with distilled one for the possible contaminants, oven-dried at 70 °C for 48 h and homogenized by particle size reduction (<0.5 mm). Neutral detergent fiber (NDF) and acid detergent fiber (ADF) analyses were performed as described by Goering and Van Soest (1970). Dry matter (DM) was fixed by using Wendee analysis method described as Bulgurlu and Ergül (1978). Dry matter digestibility (DMD) was estimated by the equation DMD % × 6.25. Powdered samples were digested with HNO_3 + $HClO_4$ mixture (Jones et al. 1991) and analyzed for calcium (Ca), magnesium (Mg), sodium (Na), potassium (K), phosphorus (P), iron (Fe), cupper (Cu), manganese (Mn), and zinc (Zn) contents by ICP-AES (Varian Liberty Series II).

Data were analyzed with the software MSTATC within the species and the difference between the phenological stages. Differences were determined by Duncan test in view of nutritive value and the mineral composition.

% = 83.58 – 0.824 ADF % + 2.626 N % suggested by Oddy et al. (1983). DMI was fixed as % of animal body weight (BW) with the formula DMI (% of BW) = 120 / % NDF published by Moore and Undersander (2002). Metabolizable Energy (ME) was computed with the formulation ME = 0.17 DMD % - 2 proposed by AOAC (1980). Total nitrogen (N) concentration was determined by the micro Kjeldahl method described by Kacar (1977). Crude protein (CP) was calculated by computation of N

RESULTS

Variation of the feed quality parameters

The dry matter content and the feeding quality of the investigated native cool season grasses were significantly different from each other through the whole phenology (Table 1). The quality parameters of those were substantially under the influence of the stage of maturity also.

Table 1. Nutritive values of native cool season grasses as an average of whole phenological stages.

	CP %	NDF %	ADF %	DMD %	DMI (% of BW)	ME (MJ/kg)
Tall fescue	9.1 e*	62.3 d	33.0 d	60.17 d	1.93 b	8.23 d
Tor-grass	8.1 g	69.0 a	39.0 a	54.82 g	1.74 d	7.32 g
Timothy	9.0 f	58.8 g	30.9 f	61.85 b	2.05 a	8.51 b
Orchard grass	9.4 d	65.9 b	36.9 b	57.12 f	1.82 c	7.71 f
Smooth brome	12.1 a	63.2 c	32.9 e	61.54 c	1.89 bc	8.46 c
Perennial ryegrass	10.8 b	59.7 f	30.6 g	62.89 a	2.03 a	8.70 a
Bulbous barley	9.9 c	61.9 e	34.9 c	58.96 e	1.97 ab	8.23 d

*Differences between the groups comprising different letters in the same column is statistically significant (P<0.05)

All the species had their highest DM, NDF % and ADF % values in late phenological stages while CP %, DMD %, DMI and ME through the earlier. Tor-grass produced the highest DM and the most lignocellulosic structure with highest NDF % and ADF % ratios whereas the lowest CP %, DMD %, DMI and ME among the species during the whole phenological stages (Table 1). The CP % of this species was almost the same with the others have at early stages but later on a remarkable decrease happened with maturity (Fig 1).

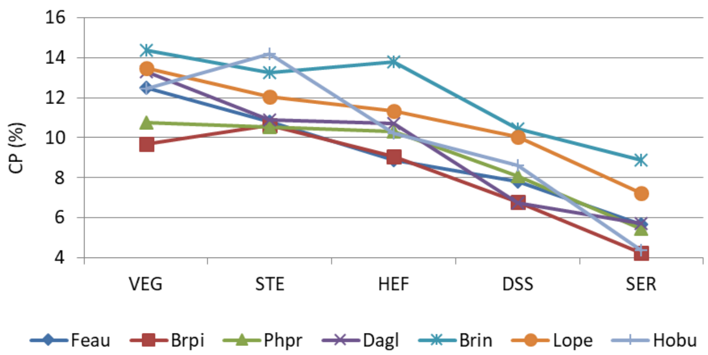

Figure 1. The effect of the plant growth stages on crude protein content of the cool season grasses.

Even though this was an acceptable ratio for early stages, it was repressed by the very high NDF % and ADF % occurred in the same period (Fig 2, 3).

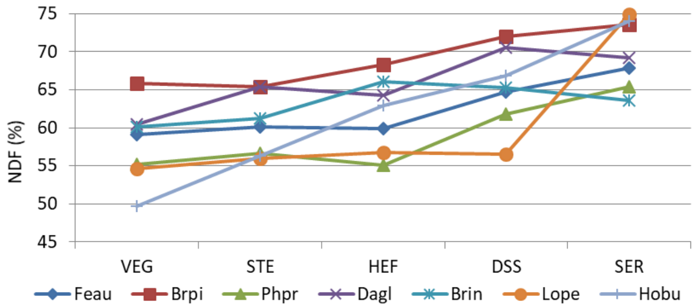

Figure 2. The variation of NDF% of the native species throughout the phenological stages.

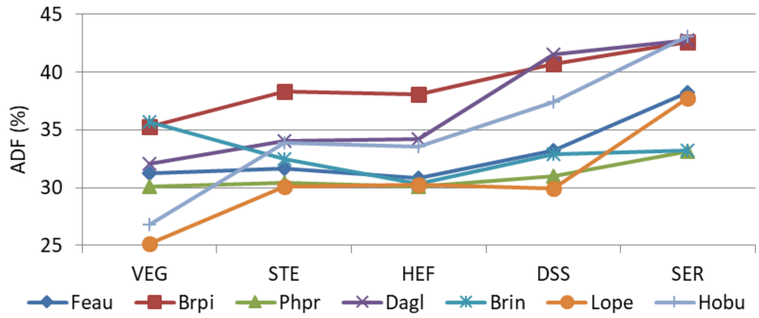

Figure 3. The variation of acid detergent fiber content of the species at different phenological stages.

As a result of this schema, the least DMD %, DMI and ME ratios were detected for tor-grass as an average of all phenological stages (Table 1). While bulbous barley generated the lowest dry matter, it was detected superior in respect to CP % at STE (Fig 1). However, this ratio fallen down rapidly with maturation. And, the end of the vegetation it reached to the lowest together with tor-grass. The minimal NDF % at early stages was appointed for bulbous barley. But, the maturation increased its fibrous structure remarkably and brought to the maximum at SER in terms of NDF % (Fig 2). The similar pattern was observed also for ADF %. While this feature was stable during STE and HEF, it attained to the highest remarkably with flowering and then (Fig 3). Inherently, digestibility, intake and ME values of this species decreased gradually whereas considerably high at VEG and STE (Figure 4, 5, 6).

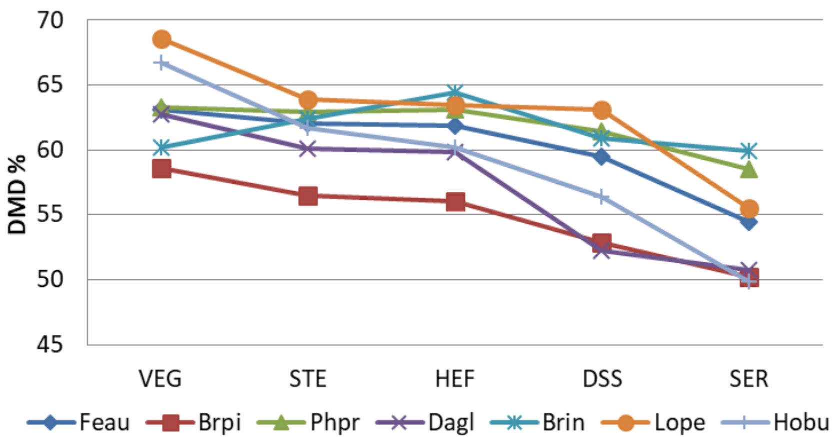

Figure 4. The effect of the plant growth stages on dry matter digestibility of the species.

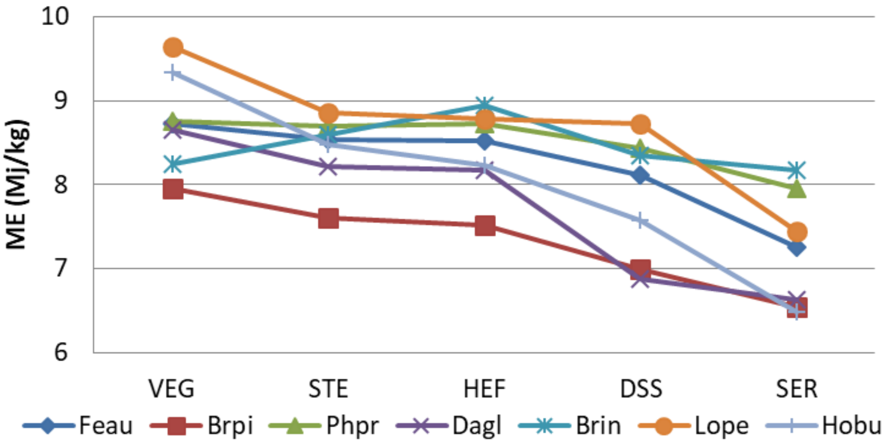

Figure 5. The variation of metabolizable energy values of the species at different phenological stages.

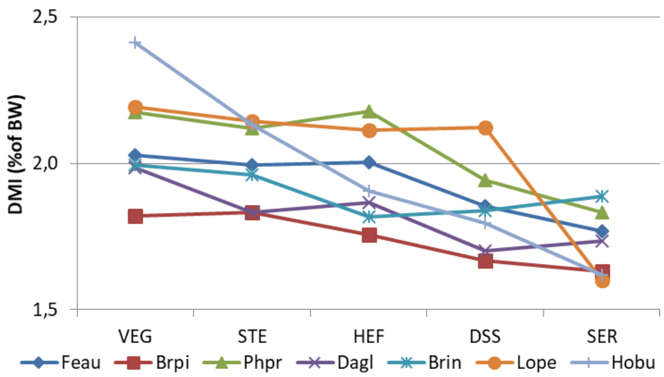

Figure 6. The effect of the plant maturation on dry matter intake (% of animal body weight) of the native cool season grasses.

On the other hand, this rate actualized more prominent for DMI %. Therefore the best grazing time for this species seems STE and HEF for an optimum energy intake. Smooth brome was specified the richest species in terms of CP % during the whole phenological stages except for STE (Fig 1). Even if its NDF % reached the maximum with a gently increase since early heading it is detected moderate as an overall average (Table 1). The variation on ADF % was exciting because of the downward trend till to HEF (Fig 3). In this respect it has an acceptable fibrous structure for the late phenology of grasses. Indeed DMD % and ME increased throughout the stages considered as grazing period and became superior at flowering (Fig 4, 5). Even a reduction was observed on mentioned values later on, the highest digestibility and metabolizable energy was concerned with smooth brome at SER. Contrarily it was detected as one of the worse species in respect to DMI % at HEF (Fig 6). But later on while the intake of the others decrease; this species approached to the highest intake ratio with a gradual increase. One of the lowest DM averages was stated for perennial ryegrass which looks rather good in terms of CP % through the phenological stages. Moreover it was generated an extremely low fibrous structure (Table 1). However this construction changed after DSS and it constituted the highest NDF % and a moderate ADF % at the late phenology (Fig 2, 3). The variations on DMD %, DMI % and ME ratios of perennial ryegrass were almost stable till DSS. But later on a significant decrease was observed for all these characteristics especially its intake (Fig 4, 5, 6). In spite of these fluctuations perennial ryegrass was appointed the most digestible species with the highest intake and metabolizable energy values (Table 1). Timothy was detected as one of the highest dry matter content with very low NDF % and ADF % especially through the grazing maturity. That's why both dry matter digestibility and intake also the feasibility metabolizing of timothy hay were come true at higher rates (Table 1). A gradual decline was observed at the amount of these affirmative characteristics with maturation. But it was not occurred as much as the others. It was also superior in terms of DMI through the vegetation but especially at HEF (Fig 6). Even though to these tempting features in respect to animal feeding, the second lowest CP % even in early stages was measured from timothy. This situation added a negative value to its forage quality. Tall fescue detected as moderate among the species in respect to the investigated features out of CP % (Table 1). If CP % comprised higher than two species had but lower than the others. The deviations arisen on the averages of these characteristics with advancing phenology. The more fibrous structure after HEF was remarkable for this species (Fig 2, 3). Therefore a gradual decrease was emerged on DMD %, DMI and ME after the same period. On the other hand the intake by the animals of this species was superior at HEF (Fig 6). Both dry matter and the quality parameters of orchard grass were quite poor (Table 1). The decrease on its dry matter content at HEF stage was considerably remarkable. On the other hand its protein content till HEF stage was detected as moderate. That's why it can be evaluated at this stage effectively. But then, while the protein content was decreasing the fibrous structure increased rapidly (Fig 1, 2, 3). The digestibility and metabolizable energy rates of orchard grass decreased gradually through the maturation. And those values become the worst among the species at DSS whereas the dry matter intake increased after the same stage (Fig 4, 5, 6).

Variation of the macro and trace element composition

Mineral element composition of the investigated cool-season grasses and the variation depending on the phenological stages were considerably significant. Nonlinear variation in other words fluctuations was observed on the mineral content between the stages (Fig 7). The vast majority of the minerals' concentration was distinctly reduced at STE to HEF and then increased remarkably from that point to DSS. The highest Ca, P, Mg and Cu, retention was determined for perennial ryegrass during the whole stages with certain minor exceptions (Fig 7a, b). It accumulated Fe, Zn and K moderately while the Mn was least. Timothy had fair averages in terms of Fe accumulation from the beginning of the vegetation to HEF, but it increased remarkably and reached the maximum level at full maturation. Oppositely the accumulated P concentration throughout the phenological stages was least. Nevertheless an average accumulation was detected for this species in respect to other elements. Tall fescue was determined as the poorest species in terms of Zn. Otherwise, the average P content was measured the maximum even it was detected below than the others had, during some of the growth stages. As shown on Fig 7b the Mn content of orchard grass was remarkably over than the others had. It was determined about two times more than the closest value throughout the whole growing periods. Although the difference was not obvious like this, the Zn content of this species was one of the highest also. Nevertheless the other minerals were rather good. On the other hand the conspicuous falling mentioned above was more clearly observed for orchard grass at HEF in respect to both macro and trace elements (Fig 7a, b). Both the maximum Zn and the minimum Mn content was detected for tor-grass. Cu concentration of smooth brome which was statistically significant with rye grass comprised the highest in overall average but especially through the maturation. K accumulation of smooth brome reached to the top among the species after the same fluctuations. The least Ca, Fe, Mg and P concentrations were measured for bulbous barley as an average of whole phenological stages. On the contrary Fe concentration at VEG and STE was evaluated the highest.

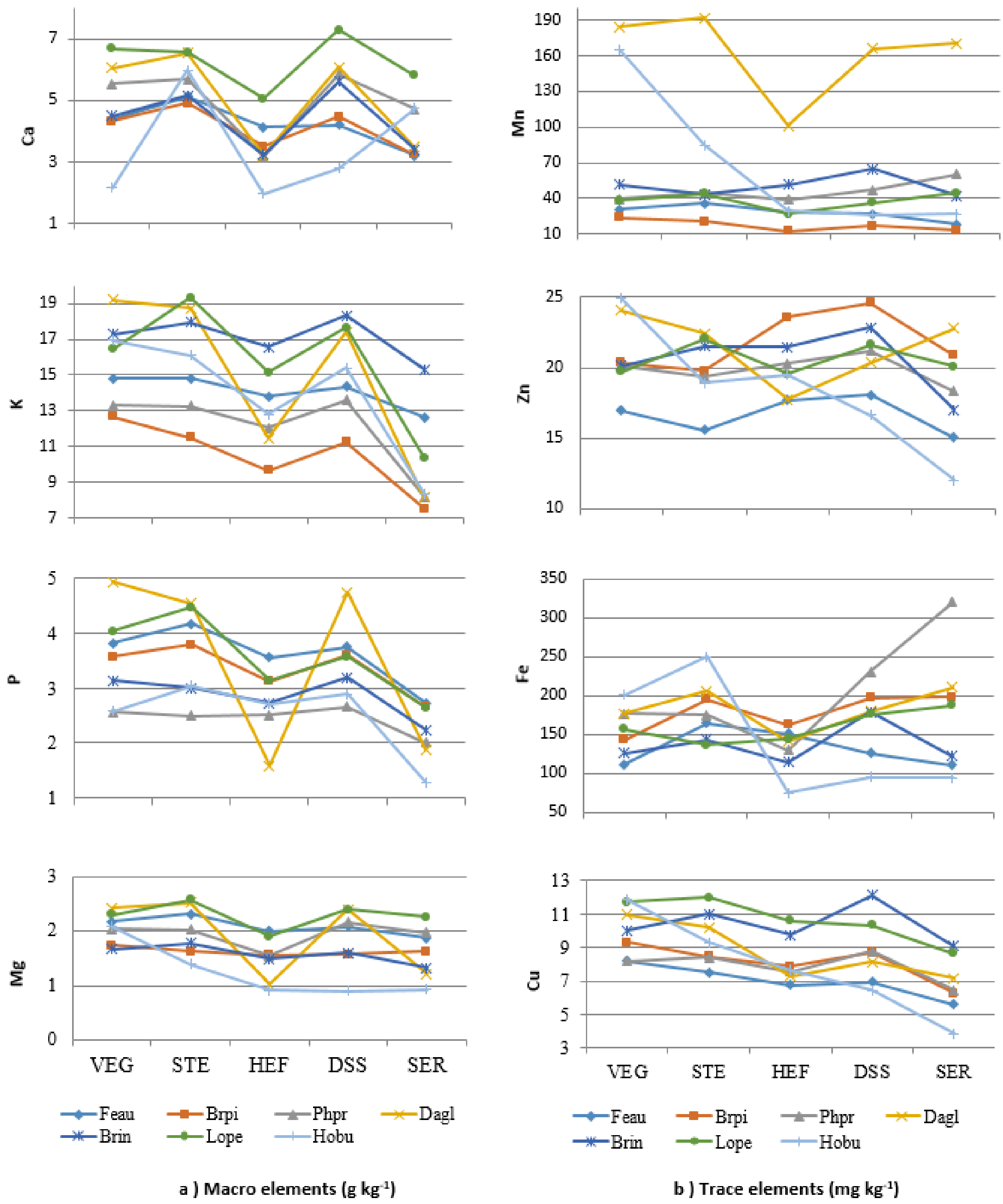

Figure 7. The variation of the mineral composition of native cool season grasses at different phenological stages.

DISCUSSION

When we discuss the quality of forage, it is possible to find many considerations and various opinions. But those associated with animal performance seems the most important (Pinkerton and Cross, 1992). In other words, how much of the forage is converted into energy by the animals. The value of forage is determined by the yield and nutritive value of dry matter. Forages vary widely in ability to produce animal products (Schroeder, 1996). Also a species is not stable in itself in terms of digestibility. It was clearly revealed out with this study.

Reid et al. (1988) determining a positive relationship between DMI and DMD in all the examined C3 and C4 plants, Allen (2000) refers to a rapid decline on DMI with increasing of NDF in the ration. Indeed, tor-grass which has the lowest DMD % throughout the all phenological stages produced the minimal ME also (Table 1). Its leaves includes high amount of lignin and sclerenchyma cells (Van Arendonk and Poorter, 1994). This structure gives a negative value to the forage in terms of conversion to animal efficiency. Although the duration and rate of DMD % and DMI varies depending on the type of fed animal. Stone (1994) ranked the cell types according to digestion such as epidermal, vascular, sclerenchyma, parenchyma, and 100% digested. Therefore the animal has a long ruminal retention time or ruminating more, digests more, in consequence of decreased particle size and the expanded surface area of diets. Cattle retained all diets for longer periods in the rumen than did sheep (Poppi et al., 1981). Tor-grass may mow several times with abundant dry matter in a season even at early phenology. Garnier and Laurent (1994) reported correspondingly with our findings, a high plant biomass density is indicative for a higher degree of scleromorphism as well as a slower turnover of leaves and roots. On the other hand higher fiber indicates generally lower protein (Putnam, 2004). This statement confirms us also. However, the CP % at STE (10.64%) (Fig 1) seems enough to satisfy the daily requirement of ewes as 70-90 g CP kg^{-1}. Digestibility and animal intake of the lignocellulosic residues can be easily increased with the usage of different biological agents (Cohen et al., 2002) and a variety of physical treatments (George and Ghose, 1983). Indeed, DMD of tall fescue hay was increased from 39.4 % to 57.4 % via NH_3 application (Buettner et al., 1982). Tor-grass is one of the rationally evaluative species to the marginal-limy pastures. Even tor grass is often ignored due to its low protein content and digestibility a valuable specification was detected especially in respect to trace minerals. Fe which deficiency causes lack of appetence and yield loss in animals was determined higher in this species compared to others had at HEF and afterwards (Fig 7b). On the other hand, Zn, component of the many enzymatic reactions that directly affect carbohydrates, proteins, lipids and nucleic acid metabolism (NRC, 2001), was the highest also. Jongbloed et al. (2004) stated daily Zn requirement of dairy cattle > 25 mg kg^{-1} and, Manske (2002) fixed it as 30 mg kg^{-1}. Therefore, 21.8 mg kg^{-1} average detected Zn content seems sufficient and should be considered. Hence, these types of species that high dry matter content, but low digestibility can be utilized in animal feeding with the help of such technologies. On the other hand such the higher fibrous hays may be used to feed the animals with lower energy requirement instead of high producing dairy cows.

Bulbous barley is resistant to overgrazing hence the underground bulbs, palatable however lower dry matter content. CP determined as 14.21 % at STE (Fig 1) is over than the daily requirement of lactating cattle so that of 100-120 g CP kg^{-1}. That was also detected similarly by Arzani et al. (2004) for the same phenological stage of this species. As specified above bulbous barley is a grazing-resistant species even in early stages so it can be grazed safely at mentioned stages. When the leaf / stem ratio that is an important quality criterion for forage, starts to decrease fodder get more stemmy and so less palatability (Pinkerton and Cross, 1992). While the nutritional value of leaves and stems were close to each other through the vegetative stage, stem feeding value and hence total quality of hay decrease rapidly at heading (Ferdinandez and Coulman, 2001). Nevertheless the chemical analyses of entire aboveground parts of a plant gives the values that are only enough to daily maintenance, but due to the selective grazing of leaves, the diet consumed by the animals is much higher in quality than measured in laboratory (Stritzler et al., 1996). So the assessment of the whole plant digestibility is more associated with stem digestibility (Casler and Carpenter, 1989). Mullahey et al. (1992) recoded that the live weight gain of the ruminants fed with more leafy hay was much more. The stems of the bulbous barley are getting longer and thicker that causes lower intake at the late phenological stages. As shown in Fig 7 the intake of bulbous barley was superior at the beginning of the vegetation. So it is important to evaluate it before getting stemmy for a desired animal performance. Periodical changes of mineral compositions had different pattern in bulbous barley than the others. That which, between preliminary and ending phenological periods the decrease of minerals were more than twice except Ca. It was detected approximately 6 times more for Mn (Fig 7b). Moreover it was one of the highest (164.7 mg kg^{-1}) content at VEG. Bulbous barley is capable of storing the redundant nutrients and minerals as nutrient replacement in its bulbs. So the mentioned decreasing occurred at the above ground parts of the plant throughout the maturity may explain with this physiological characteristic. Likewise, Gutman et al. (2001) specified a significant decrease on bulb weight in continuously clipped plots compared with controls. Fe content of bulbous barley at VEG and STE, 201.20 mg kg^{-1} and 250.10 mg kg^{-1} respectively, were over than the statement of NRC (2001) for the same growth stages of cool season grasses. The same literature was informed the daily Fe requirement of 6 weeks and 12 weeks old calves as 150 mg kg^{-1} Fe and 118 mg kg^{-1} Fe respectively. On the other hand it was stated that 24 mg kg^{-1} Fe for the cows which is capable of producing 25 kg milk daily. However Haugeni (1996) indicated that 30–50 ppm/day Fe is sufficient for sheep. The Fe content that we detected for early stages of bulbous barley was higher than testimonial values. It is one of the grazing resistant species even in early growth stages hence its bulbs. That's why it can be grazed safely while the other species do not offer sufficient minerals. However, excessive N and K in diet may cause grass tetany (*hypomagnesemia*) in lactating ewes due to reducing of Mg intake (Can and Çeliktaş, 2009). Grass tetany symptoms were observed rarely if K/(Ca+Mg) tetany ratio < 2.2 (Jefferson et al., 2001). This ratio was determined rather high for bulbous barley throughout the growth stages (Fig 8). It reached the peak considerably during the grazing maturity. That's why the more attention should be given while grazing the pastures dominated with this species.

Smooth brome is resistant to heavy grazing and being crushed also even in early growth stages hence its strong rhizome system. It is highly preferred by the animals because of its palatability. However, tastiness and nutritive values decrease rapidly after flowering (Howard, 1996). This detection supports to our findings. Indeed, the highest CP % (12.1) was measured throughout the phenological stages (Table 1). But DMD % and ME values significantly reduced from HEF to the subsequent stages even those were superior at grazing maturity (Fig 4, 5).

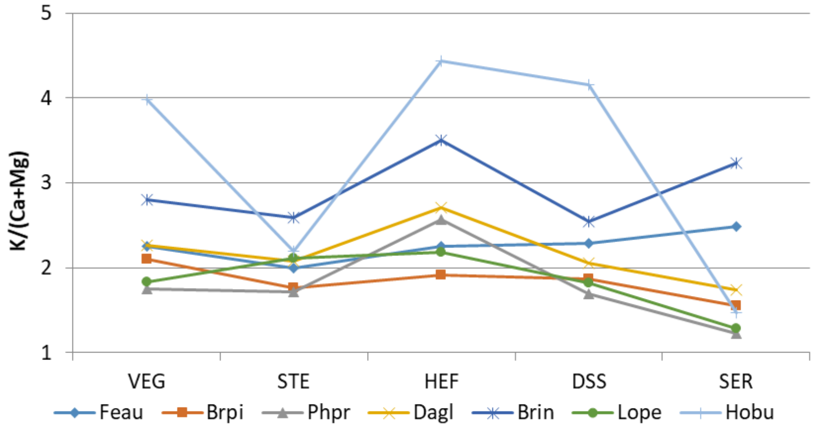

Figure 8. The variation of Grass Tetany Ratio (K/(Ca+Mg)) of the cool season species depending on the growth stages.

Ferdinandez and Coulman (2001) stated that being a very fast accumulation of lignin in stem cell walls expose to this situation. Despite that situation the DMI of smooth brome started to increase at HEF and then (Figure 6). This may because of the variation on NDF % and ADF % at mentioned stages. Because ADF estimates forage digestibility, and NDF provides an estimate of forage intake (Caddel and Allen, 1994). NRC (2001) foresees the CP of temperate grasses at early growth stages as 18 % (immature) - 13.3 % (mid maturity). CP % detected with this study at VEG, STE and HEF stages are partly overlaps the predictive values (Fig 1). Cu deficiencies may appear especially at grazing conditions. It is a constituent of the enzyme and because of this undesirable symptoms may be observed on animals at deficiencies. Cu content of smooth brome in this study (10.392 mg kg^{-1}) seems enough to satisfy the daily requirement of grazing livestock and poultry proposed as 4-10 mg / day Cu by McDowell and Conrad (1977). Storage of potassium by the animals is not more therefore daily requirement is so much. Smooth brome was determined the best in respect to accumulation of this macro element with 17.0 g kg^{-1} K. The daily K requirement for highly productive cattle was specified as 10 g kg^{-1} of the DM (NRC, 2001). On the other hand as it discussed above, this high K ratio reduced the Mg content. Therefore the tetany ratio was calculated as 2.85 for smooth brome. So in respect to this situation one of the highest ratio and risky species emerged as shown in Figure 8.

Feed conversion efficiency (DMD and ME) of perennial ryegrass was superior (Table 1). This is because of its high leaf/stem ratio and lower lignocellulosic structure. This finding confirms the general rule as "the more digestible the forage, the more energy the animal gets" stated by Pinkerton and Cross (1992). Fast growing species accumulated more organic N-compounds as well as organic acids which are the cytoplasm compounds, whereas slow growing species accumulated more lignin, (hemi) cellulose and insoluble sugars thus incorporated with cell walls (Niemann et al., 1992; Poorter and Bergkotte, 1992). Perennial ryegrass is one of the fast growing species with 214 mg g^{-1} day^{-1} relative growth rate (RGR) according to measurements of Poorter and Remkes (1990). They also expressed the RGR of Tor-grass as 174 mg g^{-1} day^{-1}. This evidence is in agreement with our findings. Since we discussed previously tor-grass is highly fibrous as the general characteristics of slow growing ones. Despite the valuable characteristics of perennial ryegrass the very sharp decrease on dry matter intake at DSS was quite remarkable (Fig 6). That chart was inverse symmetry with NDF % as shown in Fig 2. Indeed, Kilcher (1981) mentioned to this situation. He reported that intake of the digestible nutrients may be reducing 30 % after flowering. Poorter and Bergkotte (1992) indicated that fast growing species also accumulate the minerals more. Actually it was detected as a wealthy species in terms of most minerals in this research (Fig 7). The highest Ca concentration was detected for this species throughout the all phenological stages. But it was more distinctive at DSS with 7.29 g kg^{-1} Ca (Figure 7a). Ca accumulation increases in green canopy during stem elongation and boot stages due to so much calcium binding points on cell walls. But the mineral content decline rapidly in next stages as seen in this study because of the orientation of minerals towards to seeds and the other storage tissues. At the case of Ca deficiency, some disorders in bone development may emerge hence 98% of calcium of animals have located in the skeletal system. Daily Ca requirement of cattle which is over 450 kg live weight is suggested 5 g by Goff (2002). The measured content as 6.275 g kg^{-1} Ca for Perennial ryegrass in this research seems enough to satisfy the mentioned requirement. On the other hand the highest Cu (10 649 mg kg^{-1}) accumulation was also detected the analyses of perennial ryegrass hay even it decreased after stem elongation (Fig 7b). Although Reid et al. (1988) stated the daily Cu requirement of beef cattle as 8 ppm, they emphasized that this requirement is dependent on the concentration of Mo in ruminants. Cu requirement of animals increases depending on the increase of Mo and S concentrations of diet (Greene, 1997). Accordingly a significant reduction on the proportion of Cu intake was reported by Comar et al. (1949) with stimulating the Mo content of diet from 10 mg to 100 mg. That is, Mo represses to the Cu storage. Grazing the animals with fast growing C3 plants have a greater risk in terms of grass tetany (Mayland and Sleper, 1993). Whereas, we detected the K/(Ca+Mg) tetany ratio for perennial ryegrass that is a fast growing temperate grass also, as 1.83 (Fig 8). Therefore it has been one of the low risky species in this respect.

According to the RGR measured by Niemann et al. (1992) timothy is a fast growing species. Daily growth rates of its leaves, number of leaves at per stem and the survival time of the leaves were determined a little more than perennial ryegrass (Peeters, 2012). Research findings in this study related to this species were reflected to the general features of fast growing species. It is revealed that one of the highest average of ME hence its low lignocellulosic structure (Fig 2, 3, 5). It is highly preferred and selectively grazed by the animals because of those features. This means that it is a decreaser in the vegetation and therefore may easily disappear. Its CP % was higher than the other species have at vegetative stages but decreases rapidly with maturation (Hall and Cherney, 1991). Even our findings are compatible with this respect, the CP % was rather low than some of the literature statement. On the other hand it was over than the ratio decelerated by Esser (1993). Such different results may occur when studied with different ecotypes in different ecologies. It is possible to find different ecotypes of timothy adapted to different ecological conditions hence its enormous adaptability. A high nutrient storage ability of the species procreates the adaptability (Yamamoto et al., 2010). Timothy may store high concentration of carbohydrate in forms of fructose in its leaves and enlarged lower internodes known as haplocorm. Delaying grazing will reduce timothy's stored energy reserves and ultimately reduce its persistence. Anyway as shown in Fig 6 DMI reduces after HEF. These reserves provide to plant viability in extreme conditions by defending it against to stress factors directly or indirectly (Tamura et al., 2009). Mayland (2000) correlated the palatability and being preferred by animals with the storage capacity of water soluble carbohydrates (WSC) like fructose. Humphreys (1989) stated a positive correlation between WSC and DMD but negatively with CP. The higher DMD % and lower CP % detected in our research seems to confirm to this correlation (Table 1). The quantified Fe average of timothy (206.5 mg kg^{-1}) was the highest among the species (Fig 7b). It was quite over than daily requirement of cattle which are different age and productivity specified by NRC (2001). Sandrin et al. (2008) reported that the leaf Fe concentration is stimulated the accumulation of WSC like fructose in plants grown under polluted lands with heavy metals. Thus, the increase on Fe concentration of timothy since HEF is remarkable for this aspect (Fig 7b). Because WSC like fructose were accumulated rapidly in haplocorms since that and the next phenological stages. Jacobson and Oertli (1956) mentioned a positive correlation between leaf chlorophyll content and accumulated Fe. Therefore, the higher photosynthetic efficiency is expected from timothy hence its high Fe retention. The proportion of Ca and P in diet is critical in terms of animal feeding. But, the ratio between these two minerals should also be considered while evaluating the requirement. Just because when dietary phosphorus exceeds dietary calcium, absorption of calcium from the digestive tract is reduced. Thus the animal will metabolize bone calcium to meet the requirement such a condition. Even timothy is determined as one of the poorest species with respect to P accumulation; it was within the boundaries of the reference range stated by McDonald et al. (1995). NRC (2001) indicated that P concentration of ration should be about 0.24 %. This ratio is identical to those we determined for timothy. The same ratio was also specified by Winter and Gupta (1983) as an average of 107 locations. On the other hand timothy had the highest Ca/P ratio (2.08) among the investigated species (Fig 9). The ideal Ca/P ratio of diet was recommended 2:1 or 1:1 for dairy cattle (ARC 1980). Timothy is also evaluated the least risky plant in terms of grass tetany hence its K/(Ca+Mg) tetany ratio as 1.72. But ratio at HEF which is over the safety limit should be considered (Fig 8).

Tall fescue is more tolerant to continuous grazing compare to many other species under proper usage. The hay quality was moderate in comparison with the other examined species. Indeed Stevens et al. (1992) reported that feeding the goats with timothy generated the highest live weight gain, in case tall fescue was provided moderate. Nevertheless Bagley et al. (1983) mentioned that the advantages of tall fescue in terms of animal feeding hence its longer grazing season.

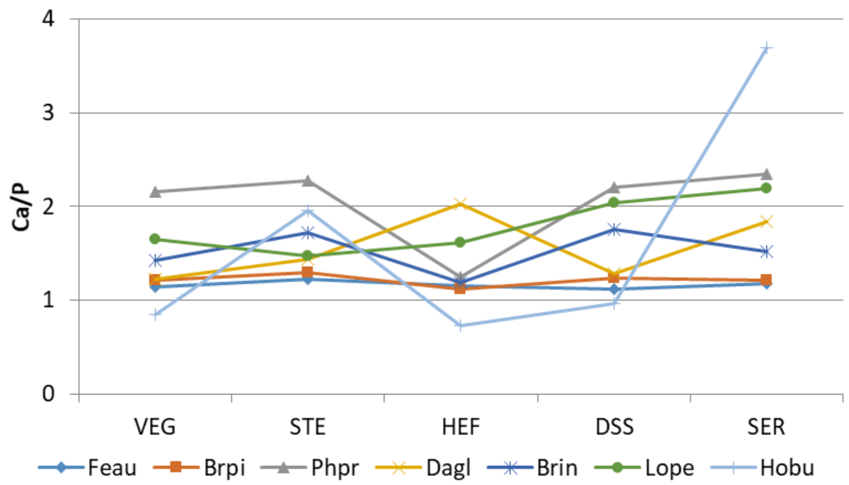

Figure 9. The variation of Ca/P Ratio of the cool season species at different phenological stages.

Likewise the animal performance was determined greater by McFarlane (1990) at late summer grazing of this species. At the same time productivity increases more with high-intensity grazing of tall fescue (Stevens et al., 1992). The animals do not too much prefer Tall fescue in vegetation due to less palatability and toxicity problem even observed rarely. Therefore it is an increaser and may become dominant within the mixtures with improper utilization (Wright et al., 1985; Hannaway et al., 1999). The forage quality and feeding value of tall fescue decreased with maturity such as the other species. This status was conspicuously clarified with full maturity (Figures). So, if the plants can be retaining in the vegetative stage constantly the quality and animal intake will be higher also. However both regrowth rate and also hay quality may reduce when grazing or clipping were postponed after HEF or early blooming (Hannaway et al., 1999). Indeed Lacefield et al. (1995) indicated that DMD for fall, spring and summer clipping of tall fescue hay as 74 %, 69 % and 66 % respectively with a similar schema on palatability. We detected lower DMD % than those values for the same species (Table 1). The arising contradiction may because of while this research was conducted on natural pastures, but the other under controlled plots with the commercial species. That's why tall fescue may produce high quality with more digestible forage via proper management and utilization practices. The highest P content (3.6 mg kg^{-1}) among the investigated cool season grasses in this research was detected for tall fescue (Fig 7a). So the minimal Ca/P ratio (1.16) emerged hence this accumulation (Fig 9). It was within the reference range mentioned above. K/(Ca+Mg) tetany ratio for Tall fescue was calculated as 2.22 (Figure 8). Even it was at the line through the late phenological stages should be noted in this respect. Clark et al. (1987) reported the Ca/P 2.2 and tetany ratio 1.2 as an average of 203 tall fescue samples. The results are incompatible with our findings. But it should be noted that these ratios are calculated from the blended samples which are clipped only at vegetative stages. When the amount of dietary P level falls below 3 g kg^{-1} the deficiency symptoms may observe in cattle. The dietary P level should be in the range of % 0.36-0.40 for a reliable feeding program (NRC, 2001). The same literature indicates the daily requirement of Ca and Mg for cattle as 6.5 g kg^{-1} and 2.5 g kg^{-1} respectively. In this research while Ca accumulation of tall fescue actualized below than those, P and Mg concentrations at grazing maturity seem enough. Moreover tall fescue was determined as the poorest species beside the other cool season grasses investigated in respect to trace minerals Zn, Cu and Fe which are the component of important metabolic functions within the animals (Fig 7b).

Niemann et al. (1992) stated the orchard grass as the fastest growing species with 229 mg g^{-1} day^{-1} RGR. period extended 20 days more at these types of paddocks. Min and Vough (2000) reported that the paddocks getting more productive via frequently clipping under a proper fertilization when the fall regime is good, but not during the drought periods. Mowing frequency causes the significant variation on the mineral element concentration of grasses. It is possible to obtain desired amount when the all kinds of maintenance process are done. Thusly Gralak et al. (2006) measured a significant increase on the mineral content of some grasses at 3th and 4th mowing from the fully managed plots. But we obtained higher mineral contents than those declarations from the native orchard grass. The same authors also mentioned a negative correlation between TDN % and Fe, Mn and Cu accumulation. Indeed we detected the amount of these trace minerals rather high for orchard grass that was assigned one of the less digestible species with low ME (Fig 7b). On the other hand very sharp decrease and then sudden increase in other words fluctuations on P, Mg and Ca content of orchard grass at HEF stage was remarkable (Fig 7a). The actively growing tissues include more P, Mg and K comparatively non active ones (Greene, 1997). HEF is the stage which is the vegetative growth reducing despite that generative tissues are rapidly growing towards DSS. That's why such those fluctuations on mineral content may observed. Oresnik et al. (1999) were stated the orchard grass as a wealthy species in terms of Mn accumulation. Our finding was completely similar and remarkable on this respect (Fig 7b). On the other hand it was rather high than the recommendation of NRC (2001) for the cattle as 40 mg Mn kg^{-1} DM daily. Any toxicity was reported for orchard grass. However the calculated K/(Ca+Mg) tetany ratio as 2.71 at HEF stages However, our findings displayed that orchard grass is highly cellulosic and slight digestible species contrary to expectations from the fast growing species (Table 1). Actually the detected values for mentioned features are in the range of the statements of NRC (2001) for moderately matured cool season grasses. However DMD and ME values of orchard grass decreased rapidly and became the worst especially after HEF (Fig 4, 5). This species has the higher leaf/stem ratio beside the other cool season grasses. But it turns stemmier (leaf/stem 1.39) with maturity hence the fast decrease on leafy structure (2.39) detected at early growth stages (Baron et al., 2000). It is notified as 3.82 for re-growing plants after clipping which means more quality hay. Likewise the live weight gain and milk yield of the cattle where grazed in frequent rotation paddocks significantly increased (Coblentz et al., 2004). Moreover the grazing makes the grazing a little bit risky during this period (Fig 8).

Consequently the quality of the forage is extremely variable in respect to nutrient content and the digestibility between interspecific and intraspecific. The animal intake and digestibility are also affected by the morphological characteristics of the forages. The species which have thick and longer leaves, wide leaf area, more leaf capacity and weight are digested more (Ferdinandez and Coulman, 2001). Both these morphological characteristics even leaf/stem ratio and also some chemical content of the cell may improve. By this way highly digestible, nutritive and quality forages may be produce via different breeding and genetic manipulating methods (Casler and Carpenter, 1989; Ferdinandez and Coulman, 2000; Chen et al., 2004). However working with the climax species of that ecology gives big advantages at these kinds of breeding program.

CONCLUSION

The usage of the roughages at ruminant feeding is an obligation in respect to both digestion physiologies of the animals and also feeding cost. On the other hand it is an important necessity in terms of the addition amount of concentrated feed or the other feed additives into ration in view of reflection the genetic codes to phenotype and prevention the abnormalities based on mineral deficiencies. The mineral accumulation and the conversion of the chemical structure of the plant cell walls is the key on digestibility since being a significant interactions between minerals and organic constituents which may reduce the forage bioavailability. Knowledge on this reaction will help us to estimate how much of the forage the animal can eat and how much energy the animal can get what it eat. This metabolism is affected by many biotic and abiotic agents one way or another. But the stage of growth at mowing or grazing seems the most critical even if the optimum conditions in every respect are verified. It is also a factor that can interfere by the pasture managers. Priorities will vary according to the circumstances. Thus the information on the variation of nutritive value and the mineral composition of native pastures could help the decisions of managers on suitable timing of harvest or grazing. Moreover, if any mineral supplementation to diet is required or not? Combining knowledge of animal nutrition, on-farm hay quality, and management provides for cost effective crop production and vigorous animal growth which are essential a sustainable and profitable farm.

ÖZET

Amaç: Doğru bir mera yönetimi ve hayvan besleme ilkeleri açısından mera kompozisyonu üzerinde detaylı kimyasal inceleme ve yoğun bir bilgiye ihtiyaç vardır.

Yöntem ve Bulgular: Mevcut araştırmada; doğal çok yıllık serin mevsim buğdaygil türleri, *Festuca arundinaceae* L., *Brachypodium pinnatum* (L.) Beauv., *Phleum pretense* L., *Dactylis glomerata* L., *Bromus inermis* Leyss., *Lolium perenne* L. ve *Hordeum bulbosum* L. beş farklı bitki gelişim döneminde hayvan besleme kalitesi açısından değerlendirilmiştir. Bitki kimyasal kompozisyonu, kalite ve dolayısıyla besleme değerleri yani hayvan performansı bitki gelişim dönemlerinden doğrudan etkilenmektedir. İncelenen tüm türlerde kuru maddenin sindirilebilirliği, alımı ve protein içerikleri bitki olgunlaşması ile birlikte azaltırken, lignifikasyon artmıştır.

Genel Yorum: İnce uzun yapraklı ve yaprak/sap oranı yüksek olan türlerin sindirilebilirlik oranlarının daha yüksek oldukları belirlenmiştir. Hızlı büyüyen türlerde ise metabolize olabilir enerji içeriğinin yüksekliği dikkate değer bulunmuştur Mineral elementlerin büyük çoğunluğunun konsantrasyonu sapa kalkma ve çiçeklenme dönemi arasında belirgin şekilde azalırken, bu dönemden başak/salkım çıkarma aşamasına kadar önemli bir artış saptanmıştır. Hızlı büyüyen türlerde mineral element birikimi de daha fazla gerçekleşmiştir. İncelenen türlerde çayır tetanisi riski (K/(Ca+Mg)) çiçeklenme aşamasında belirgin bir şekilde artış göstermiştir. Hesaplanan Ca/P oranının, tüm türler için rasyonda olması önerilen sınırlar içinde bulunduğu değerlendirilmiştir.

Çalışmanın Önemi ve Etkisi: Araştırma bulguları incelenen doğal mera bitkilerinin, çoğu mineral element açısından çiftlik hayvanlarının günlük gereksinimlerini, herhangi bir ilaveye gerek olmaksızın karşılayabilecek kapasitede olduklarını ortaya koymuştur.

Anahtar Kelimeler: Bakım gereksinimi, besleme kalitesi, bitki gelişme dönemi, çiftlik hayvanı, doğal buğdaygiller.

Conflicts of Interest

The authors declare no conflicts of interest.

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