

Forage yield and nutritional quality determination of huser plateau pasture (Rize, Türkiye)

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Abstract

This study evaluated the forage yield and nutritional quality of Huser Plateau pasture in Rize, Türkiye, over the 2023-2024 growing seasons. Utilizing quadrat sampling and Near-Infrared Reflectance Spectroscopy (NIRS), we determined an average dry yield of 102 kg/da. The average crude protein (CP) content was 16.29%, indicating substantial forage potential. Acid Detergent Fiber (ADF) and Neutral Detergent Fiber (NDF) averaged 29.74% and 56.67%, respectively, revealing temporal fluctuations in digestibility. Calculated parameters indicated moderate to high forage quality, with Digestible Dry Matter (DDM) at 65.73%, Dry Matter Intake (DMI) at 2.19%, and Relative Feed Value (RFV) at 112.29. Digestible Energy (DE) was 3.08 Mcal/kg, and Metabolizable Energy (ME) was 2.53 Mcal/kg. Mineral analysis showed adequate phosphorus (0.32%) and potassium (1.91%) levels, while calcium (1.30%) and magnesium (0.23%) ratios varied between years. The Ca/P ratio averaged 4.25, and the K/(Ca+Mg) ratio averaged 1.46. These findings highlight the Huser Plateau pasture's significant forage potential, suggesting that strategic management practices are essential to mitigate seasonal variations and optimize livestock productivity.

Keywords: Forage quality, Huser plateau, Nutrient composition, Rize, Yield

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INTRODUCTION

Pastures and meadows constitute indispensable roughage sources for animal nutrition, holding a pivotal position within livestock farming operations (Aydın & Uzun, 2005). These ecosystems serve as critical reservoirs of genetic resources for cultivated flora, provide vital habitats for wildlife, and perform essential ecological functions, including the preservation of biodiversity and the mitigation of soil erosion (Çomaklı & Menteşe, 1999; Carlier et al., 2005). In Turkey, approximately 70% of livestock production is dependent on pastures and meadows, which contribute substantially to the annual roughage requirements of livestock, particularly with respect to essential nutrients such as crude protein and starch (Gökkuş, 1994; Okatan & Yüksek, 1997; Çınar *et al.*, 2005; Çomaklı, 2018).

Studies on pasture and meadow vegetation are primarily conducted for two main purposes. The first is to gather data on the quantitative and qualitative characteristics of pasture and meadow areas in regions where vegetation information is limited. The second aim is to observe the effects of methods and their impacts on vegetation in pasture and meadow improvement and management practices (Cerit and Altın, 1999; Ağın and Kökten, 2013; Seydoşoğlu *et al.*, 2018; Seydoşoğlu and Kökten, 2018; 2019).

When examining studies on pastures conducted in various regions of Turkey; Tutar (2017) aimed to compare the botanical composition and yield of four different aspects of a natural pasture in Ormanardı Village, Central District of Bingöl Province. The highest crude protein content (12.9%) was observed in the southern aspect, which was statistically similar to the western and eastern aspects. Crude protein yield ranged from 2.3 to 16.7 kg/da, with significant differences among aspects. Crude ash, ADF, NDF, digestible dry matter, dry matter intake, and relative feed value ranged from 6.8% to 8.3%, 34.8% to 37.4%, 52.5% to 62.7%, 59.7% to 61.7%, 1.92 to 2.08%, and 91.8 to 109.4, respectively. The pasture contained 58 different taxa belonging to 49 genera from 21 families. Çağan et

al. (2014) conducted a study in two different natural pasture areas, one protected and one grazed. In the protected area, dry herbage yield was 203.70 kg/da, fresh herbage yield was 781.28 kg/da, and the botanical composition consisted of 38.33% grasses, 31.94% legumes, and 29.73% other families. The pasture quality degree was 4.34, and the pasture condition was medium. The crude protein, ADF, and NDF contents were 19.69%, 29.48%, and 43.31%, respectively. In the grazed area, dry herbage yield was 106.85 kg/da, fresh herbage yield was 288.68 kg/da, and the botanical composition consisted of 26.53% grasses, 23.65% legumes, and 49.80% other families. The pasture quality degree was 3.39, and the pasture condition was poor. The crude protein, ADF, and NDF contents were 15.40%, 37.76%, and 50.86%, respectively. Tanrıverdi (2019) evaluated the botanical composition and yield of a natural pasture area in Kırıbaşı Village, Central District of Muş Province, according to aspects. The highest crude protein content (14.37%) was observed in the eastern aspect, which was statistically similar to the southern and western aspects. Crude protein yield ranged from 3.31 to 7.68 kg/da, with significant differences among aspects. Crude ash, NDF, ADF, digestible dry matter, dry matter intake, and relative feed value ranged from 6.4% to 8.7%, 57.0% to 59.8%, 21.2% to 34.0%, 62.4% to 72.3%, 2.00 to 2.10%, and 102.0 to 112.5, respectively. A research conducted by Tutar and Kökten (2019) in Ormanardı Village, Central District, Bingöl Province, located in the Eastern Anatolia Region of Turkey, aimed to compare the yield and quality of a natural pasture's four different aspects. Hay yield varied between 23.2 and 129.3 kg da⁻¹ across the pasture aspects, showing statistical significance ($p < 0.01$). The grazing capacity of the pasture was calculated as 18.4 Animal Units (AU). The study also determined that CP yield and CP ratio ranged from 2.3-16.7 and 9.9-12.9%, respectively. ADF, NDF, DMI, DDMI, and RFV were found to be 34.8-37.4%, 52.5-62.7%, 1.92-2.08%, 59.7-61.7%, and 91.8-109.4, respectively.

The primary objective of this research is to evaluate the forage resources and overall ecological integrity of Huser Pasture, situated in Rize, Türkiye, through a detailed analysis of forage yield and nutritional characteristics. It is anticipated that the results of this investigation will furnish critical data for the implementation of sustainable livestock management strategies within the local context. Moreover, this study seeks to elucidate the pasture's ecological and productive attributes, thereby establishing a baseline for subsequent research and facilitating evidence-based decision-making in regional agricultural practices.

MATERIALS AND METHODS

This research was conducted in Huser Plateau pasture, situated within the Çamlıhemşin district of Rize province, a region renowned for its exceptional natural beauty and rich biodiversity within the Eastern Black Sea Region of Türkiye. The study site is located at an approximate altitude of 2300 meters above sea level, approximately 12 km from the district center. The research period encompassed the years 2023 and 2024, allowing for the observation of seasonal variations in vegetation. The geographical location of the study area is illustrated in Figure 1, providing a regional context. Representative photographs of the site's characteristic features, including topography, vegetation cover, and dominant plant communities, are presented in Figure 2, offering a visual representation of the study environment.

Soil samples were collected from representative locations within the Huser Plateau pasture to characterize the physicochemical properties of the soil. These samples were analyzed to determine key parameters relevant to pasture productivity and plant nutrition. The analysis revealed the following characteristics: soil saturation was measured at 64.9%, indicating a medium level of water retention. The soil pH was 4.59, classifying it as moderately acidic. The total salt content was low at 0.11%, while the lime content was also low at 0.10%. The organic matter content was 3.19%, considered sufficient for supporting plant growth. Available phosphorus (P_2O_5) was measured at 6.57 kg/da, indicating a medium level, and available potassium (K_2O) was 56.29 kg/da, classified as sufficient. Analysis of long-term meteorological records obtained from the Turkish State Meteorological Service (MGM) indicates an average annual temperature of 14.5 °C and a substantial annual precipitation total of 2300 mm for Rize province (Anonymous, 2025).



Figure 1. Location of the study area on the map (Google Earth)



Figure 2. Some photos taken from the study area

Plant material was collected from twelve distinct locations within Huser Plateau pasture during July of both 2023 and 2024, coinciding with the period of peak biomass production. This sampling strategy aimed to capture the seasonal variation in vegetation composition and nutritional quality. At each location, vegetation was harvested at ground level using 50×50 cm quadrats, ensuring representative sampling of the plant community. Immediately after harvesting, fresh weights of the collected samples were measured in situ using a portable precision balance to minimize moisture loss prior to further processing. Subsequently, samples were oven-dried at 70°C for 48 hours to achieve a constant dry weight. These dry weights were then used to calculate yield per unit area (kg/da). The dried plant material was ground and homogenized using a mill equipped with a 1 mm sieve to ensure sample uniformity for subsequent chemical analyses.

The concentrations of crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), acid detergent protein (ADP), and the minerals phosphorus (P), potassium (K), calcium (Ca), and magnesium (Mg) were determined using Near-Infrared Reflectance Spectroscopy (NIRS) with a Foss NIR Systems Model 6500 Win ISI II v1.5 instrument. NIRS was selected for its rapid, non-destructive, and cost-effective analysis of multiple constituents, allowing for efficient processing of a large number of samples.

Several key nutritional parameters were calculated based on the ADF and NDF values using established equations from the literature. Digestible dry matter (DDM) was calculated using the equation: $\text{DDM} = 88.9 - (0.779 \times \% \text{ADF})$ (Oddy *et al.*, 1983). Dry matter intake (DMI) was estimated using the equation: $\text{DMI} = 120 / (\% \text{NDF})$ (Sheaffer *et al.*, 1995). Relative feed value (RFV) was calculated as: $\text{RFV} = (\text{DDM} \times \text{DMI}) / 1.29$ (Sheaffer *et al.*, 1995). Digestible energy (DE) was estimated using the equation: $\text{DE} = 0.27 + 0.0428 \times (\% \text{DDM})$ (Fonnesbeck *et al.*, 1984), and metabolizable energy (ME) was calculated as: $\text{ME} = 0.821 \times \text{DE}$ (Mcal/kg) (Khalil *et al.*, 1986). These calculated parameters provide valuable estimates of forage quality and potential animal performance.

Furthermore, the ratios of Ca/P and K/(Ca+Mg) were calculated to assess the balance of macro elements, which is crucial for animal health and metabolic functions. Maintaining appropriate mineral ratios is essential for preventing nutritional imbalances and optimizing animal productivity.

Descriptive statistical analyses were performed on the collected data for all examined parameters. The JMP statistical software package was utilized to calculate descriptive statistics, including means, standard deviations, and ranges for each parameter. This statistical approach provides a comprehensive overview of the data and allows for comparisons between sampling years and locations.

RESULTS AND DISCUSSION

The nutrient composition of grass samples collected from Huser Plateau pasture during the two-year study period (2023-2024) is summarized in Table 1. These data provide a comprehensive assessment of the pasture's nutritional quality and reveal potential interannual variations in nutrient concentrations.

Table 1. Yield and nutritional value of Huser Plateau pasture

Features Analyzed	1. Year	2. Year	Average
Fresh Herbage Yield (FHY) (kg/da)	428±21.47	516±33.51	472
Dry Herbage Yield (DHY) (kg/da)	88±7.26	116±10.64	102
Crude Protein (CP) (%)	16.95±3.01	15.63±2.21	16.29
Acid Detergent Fiber (ADF) (%)	32.56±2.52	26.92±1.63	29.74
Neutral Detergent Fiber (NDF) (%)	66.99±4.41	46.34±3.78	56.67
Acid Detergent Protein (ADP) (%)	0.97±0.06	0.77±0.04	0.87
Digestible Dry Matter (DDM)	63.54±1.97	67.93±1.27	65.73
Dry Matter Intake (DMI)	1.79±0.12	2.59±0.22	2.19
Relative Feed Value (RFV)	88.23±8.97	136.36±14.15	112.29
Digestible Energy (DE) (Mcal/kg)	2.99±0.08	3.18±0.05	3.08
Metabolic Energy (ME) (Mcal/kg)	2.45±0.07	2.61±0.04	2.53
Phosphorus (P) (%)	0.34±0.06	0.29±0.04	0.32
Potassium (K) (%)	2.18±0.15	1.64±0.12	1.91
Calcium (Ca) (%)	0.93±0.08	1.67±0.23	1.30
Magnesium (Mg) (%)	0.11±0.04	0.34±0.12	0.23
Ca/P	2.74±0.28	5.76±0.42	4.25
K/(Ca+Mg)	2.10±0.11	0.82±0.19	1.46

The nutrient composition and yield characteristics of forage samples collected from Huser Plateau pasture during the 2023-2024 growing season are presented in Table 1. Significant interannual variations were observed in several key parameters. Fresh herbage yield (FHY) averaged 472 kg/da across the two years, with a notable increase from 428 ± 21.47 kg/da in 2023 to 516 ± 33.51 kg/da in 2024. Dry herbage yield (DHY) also exhibited a similar trend, increasing from 88 ± 7.26 kg/da in 2023 to 116 ± 10.64 kg/da in 2024, resulting in a two-year average of 102 kg/da. Crude protein (CP) content averaged 16.29%, with slightly higher values observed in 2023 (16.95 ± 3.01%) compared to 2024 (15.63 ± 2.21%). Acid detergent fiber (ADF) and neutral detergent fiber (NDF) contents showed a marked decrease from 2023 (32.56 ± 2.52% and 66.99 ± 4.41%, respectively) to 2024 (26.92 ± 1.63% and 46.34 ± 3.78%, respectively), resulting in two-year averages of 29.74% for ADF and 56.67% for NDF. Acid detergent protein (ADP) remained relatively stable across the two years, averaging 0.87%. Consequently, calculated nutritional parameters, including digestible dry matter (DDM), dry matter intake (DMI), and relative feed value (RFV), showed substantial improvement in 2024. DDM increased from 63.54 ± 1.97% in 2023 to 67.93 ± 1.27% in 2024 (average: 65.73%), while DMI increased from 1.79 ± 0.12% to 2.59 ± 0.22% (average: 2.19%). Notably, RFV exhibited a considerable increase from 88.23 ± 8.97 in 2023 to 136.36 ± 14.15 in 2024 (average: 112.29). Digestible energy (DE) and metabolizable energy (ME) also showed slight increases in 2024, averaging 3.08 Mcal/kg and 2.53 Mcal/kg, respectively, over the two years. Mineral analysis revealed average concentrations of 0.32% for phosphorus (P), 1.91% for potassium (K), 1.30% for calcium (Ca), and 0.23% for magnesium (Mg). The Ca/P ratio increased substantially from 2.74 ± 0.28 in 2023 to 5.76 ± 0.42 in 2024 (average: 4.25), while the K/(Ca+Mg) ratio decreased from 2.10 ± 0.11 to 0.82 ± 0.19 (average: 1.46).

This study investigated the forage yield and nutritional characteristics of Huser Plateau pasture over two growing seasons (2023-2024), revealing significant interannual variability in several key parameters (Table 1). The observed increase in fresh and dry matter yields from 2023 to 2024 could be attributed to variations in climatic conditions, particularly precipitation and temperature patterns, between the two years. These factors play a crucial role in plant growth, development, and biomass accumulation.

The average crude protein (CP) content of Huser Plateau pasture (16.29%) falls within the range reported in other studies conducted in Türkiye. For instance, Kılıç (2018) reported a similar CP content of 16.6% in Beypınarı pasture (Trabzon), while Şahinoğlu (2010) found CP values ranging from 16.33% to 18.64% in Koşu village pasture (Samsun). These findings suggest that Huser Plateau pasture provides a comparable level of protein to other pastures in the region, adequate for supporting livestock nutrition. However, Güllap (2010) reported lower CP values (8.26-13.12%) in Erzurum pastures, and Parlak *et al.* (2015) found a range of 9.10-13.18% in Çanakkale pastures, highlighting the influence of geographical location, altitude, and plant species composition on forage CP content.

A notable finding of this study was the substantial decrease in ADF and NDF concentrations from 2023 to 2024. This decrease is reflected in the increased DDM, DMI, and RFV values observed in 2024. Lower fiber content generally translates to improved forage digestibility and intake by livestock. The average ADF and NDF values of Huser Plateau (29.74% and 56.67%, respectively) are comparable to those reported by Şahinoğlu (2010)

(ADF: 29.82-31.99%; NDF: 46.39-55.21%) and Aydın and Başbağ (2017) (ADF: 29.78%; NDF: 47.76%). However, Nadir (2010) reported lower ADF (24.38-26.84%) and NDF (34.59-36.32%) values and consequently much higher RFV values (174.96 to 189.77), indicating potentially higher forage quality in the studied area. These differences could be attributed to variations in plant species composition, growth stage at harvest, and environmental factors.

The mineral content of Huser Plateau pasture also showed interannual variation. The average P, K, Ca, and Mg concentrations were within the range reported in other studies (Şahinoğlu, 2010; Aydın and Başbağ, 2017), suggesting adequate mineral supply for livestock. The Ca/P ratio, which is crucial for bone development and other metabolic functions, increased substantially from 2023 to 2024. The K/(Ca+Mg) ratio, another important indicator of mineral balance, decreased in 2024. These shifts in mineral ratios warrant further investigation to understand their implications for animal health and productivity.

The observed differences in forage quality and yield among studies highlight the importance of site-specific management practices. Factors such as grazing intensity, fertilization, and weed control can significantly influence pasture productivity and nutritional value.

CONCLUSION

This study, conducted in the Huser Plateau pasture of Rize, Türkiye, over the 2023-2024 growing seasons, aimed to assess the forage yield and nutritional quality of this high-altitude grassland. Utilizing quadrat sampling and NIRS analysis, we determined an average dry herbage yield of 102 kg/da, with a crude protein content of 16.29%, highlighting the pasture's potential as a valuable forage resource. The analysis revealed that while the pasture provided adequate crude protein, the variations in ADF and NDF levels between the two years, resulting in an average NDF of 56.67% and ADF of 29.74%, suggest temporal fluctuations in forage digestibility. Calculated parameters such as DDM (65.73%), DMI (2.19%), and RFV (112.29) indicated moderate to high forage quality, further supported by digestible and metabolizable energy values of 3.08 Mcal/kg and 2.53 Mcal/kg, respectively. Mineral analysis showed adequate phosphorus and potassium levels, though calcium and magnesium ratios varied significantly between years, underscoring the importance of monitoring mineral balance for livestock nutrition. Overall, Huser Plateau pasture demonstrates substantial forage potential, but strategic management practices are necessary to address seasonal variations and ensure optimal livestock productivity.

Compliance with Ethical Standards

Peer-review

Externally peer-reviewed.

Declaration of Interests

The author has no conflict of interest to declare.

Author contribution

The author read and approved the final manuscript.

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