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Forage quality and yield of Sal Pasture (Rize, Türkiye)

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Abstract

This study investigated the forage quality and yield of Sal Pasture, located in the Çamlıhemşin district of Rize province, within the Eastern Black Sea Region of Türkiye. The study was conducted during July of 2023 and 2024. Plant samples were collected from 12 different selected points using 50x50 cm quadrats, harvesting vegetation at ground level. Subsequent laboratory analyses determined key nutritional parameters. The average fresh yield was 721.50 kg/da, with a statistically significant difference ($p<0.05$) observed between the two years (748.00 kg/da in 2023 and 695.00 kg/da in 2024). Similarly, dry matter yield also showed a significant inter-annual variation ($p<0.05$), averaging 158.24 kg/da (164.00 kg/da in 2023 and 152.48 kg/da in 2024). The average crude protein (CP) content was 13.27%, indicating a moderate protein level. Fiber fractions, as measured by acid detergent fiber (ADF) and neutral detergent fiber (NDF), averaged 37.39% and 64.92%, respectively. Digestible dry matter (DDM) averaged 59.77%, and the relative feed value (RFV) was 85.66. Digestible energy (DE) and metabolizable energy (ME) averaged 2.83 Mcal/kg and 2.32 Mcal/kg, respectively. Mineral analysis revealed average concentrations of 0.22% phosphorus (P), 1.43% potassium (K), 1.47% calcium (Ca), and 0.39% magnesium (Mg). The Ca/P ratio averaged 6.68, and the K/(Ca+Mg) ratio averaged 0.77, with a statistically significant difference ($p<0.05$) observed between years for the latter (0.81 in 2023 and 0.72 in 2024). These findings provide valuable insights into the nutritional potential of Sal Pasture for livestock grazing and highlight the influence of inter-annual variability on forage quality and yield.

Keywords: Sal Pasture, Forage Quality, Nutritional Value, Yield

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INTRODUCTION

Pastures and meadows are essential roughage sources for animal nutrition, playing a crucial role in livestock farming (Aydın and Uzun 2005). These areas provide valuable gene resources for cultivated plants, habitats for wildlife, and essential ecological functions such as biodiversity conservation and erosion control (Çomaklı and Menteşe 1999; Carlier et al. 2005). In Türkiye, approximately 70% of livestock farming relies on pastures and meadows, which fulfill a significant portion of the animals' annual roughage requirements, particularly in terms of essential nutrients like crude protein and starch (Gökkuş 1994; Okatan and Yüksek 1997; Çomaklı 2018).

The investigation of pasture and meadow vegetation serves two primary purposes. Firstly, it aims to gather quantitative and qualitative data on pastures and meadows in regions where vegetation characteristics are not well understood. Secondly, it seeks to evaluate the effects of improvement and management practices on the vegetation cover of these areas (Cerit and Altın 1999).

In this context, studies conducted in various regions of Türkiye have shown that the yield and quality characteristics of pastures and meadows vary significantly depending on aspect, altitude, grazing intensity, and other environmental factors. For example, Çaçan et al. (2014) demonstrated significant differences between protected and grazed pastures, with higher dry matter yield (203.70 kg/da), crude protein content (19.69%), ADF content (29.48%), and NDF content (43.31%) in protected areas. In grazed areas, these values were 106.85 kg/da,

15.40%, 37.76%, and 50.86%, respectively. Tanrıverdi (2019) found that aspect influences crude protein content and yield in pastures in Muş, with the highest crude protein content (14.37%) observed in the east-facing aspect.

Nadir (2010) studied the forage quality and yield of pastures in Tokat and found that dry matter yield ranged from 244.08 to 276.05 kg/da, and crude protein content ranged from 16.5% to 18.8%. Candan (2014) studied the effect of cutting frequency on pastures in Samsun and found that dry matter yield ranged from 146.09 to 274.19 kg/da. Taşdemir (2015) examined the effect of aspect on pastures in Elazığ and found that crude protein yield ranged from 141.3 to 282.3 kg/da. Öner (2016) examined the effect of altitude on forage quality in Erzurum and found that dry matter yield was 134.83 kg/da in ungrazed areas and 68.21 kg/da in grazed areas. Tutar (2017) investigated the effect of aspect on pastures in Bingöl and found that the highest crude protein content (12.9%) was observed in the south-facing aspect. Severoğlu (2018) investigated the effect of slope on forage quality and found that forage quality decreased with increasing slope.

This study endeavors to assess the forage potential and overall pasture quality of Sal Pasture in Rize, Türkiye, by meticulously analyzing its forage yield and quality attributes. The findings are anticipated to provide valuable insights that can contribute to the sustainable management of livestock activities within the region. Furthermore, this research aims to offer a comprehensive understanding of the pasture's ecological and productive characteristics, which may serve as a foundation for future studies and informed decision-making in regional agricultural practices.

MATERIALS AND METHODS

Study Area: Location, Soil, and Climate Characteristics

This research was conducted in Sal Pasture, located in the Çamlıhemşin district of Rize province, renowned for its natural beauty within the Eastern Black Sea Region. The study site is situated approximately 2000 meters above sea level and approximately 19 km from the district center. The research was carried out during the years 2023 and 2024. The location of the study area is presented in Figure 1, and some photographs of the site are provided in Figure 2. Sal Pasture represents a significant example of the characteristic pasture ecosystem of the region.

Soil samples from Sal Pasture were analyzed to determine key physical and chemical properties. The analysis revealed a saturation percentage of 75.9%, classified as clay loam. The soil pH was measured at 4.67, indicating a strongly acidic reaction. The total salt content was 0.17%, classified as slightly saline. The lime (calcium carbonate) content was 0.12%, indicating low lime content. The organic matter content was found to be 2.09%, classified as medium. Available phosphorus (P_2O_5) was measured at 4.76 kg/da, and available potassium (K_2O) was measured at 30.47 kg/da, both classified as medium. Analysis of long-term meteorological records indicates that the average annual temperature for Rize province is 14.5 °C, with an annual total precipitation of 2301.2 mm (Anonymous 2025).

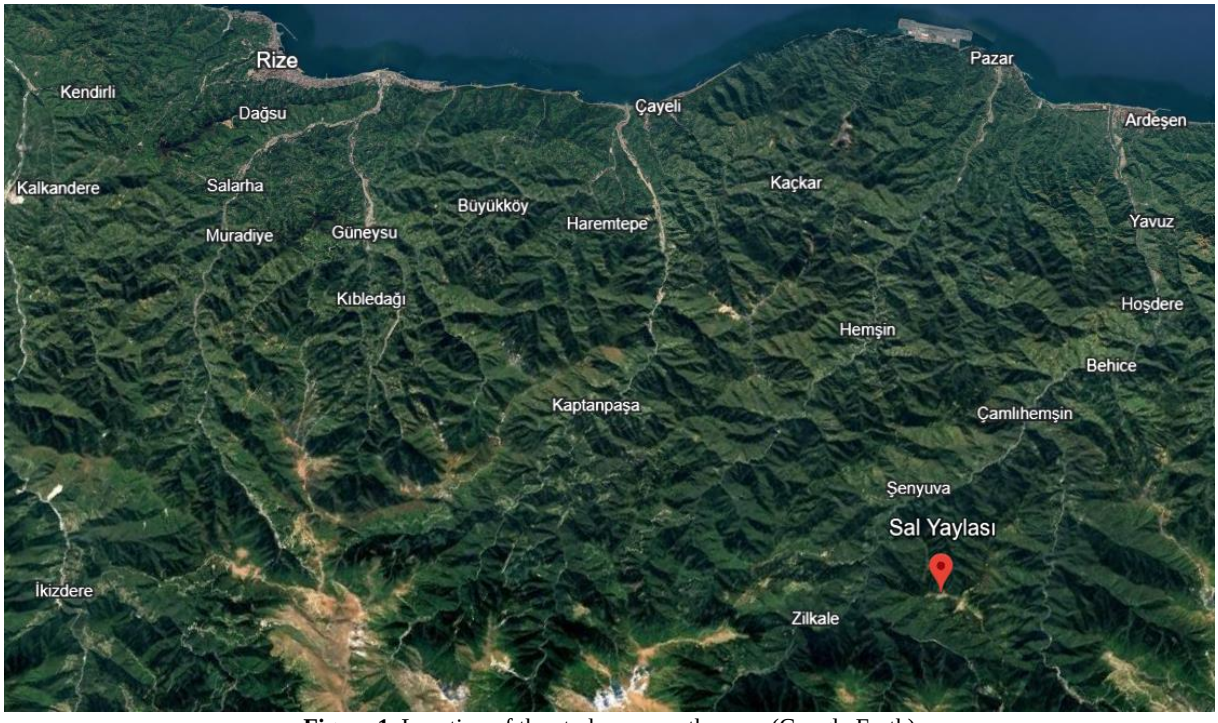

Figure 1. Location of the study area on the map (Google Earth)

Figure 2. Some photos taken from the study area

Methodology

In this study, plant samples were collected from 12 different selected points within the Sal Pasture area during July of 2023 and 2024. Samples were harvested by cutting the vegetation at ground level using 50x50 cm quadrats. Fresh weights of the collected samples were measured in situ using a portable precision balance. Subsequently, the samples were dried at 70 °C for 48 hours to determine their dry weights, which were then converted to yield per unit area (kg/da). The dried plant samples were ground and homogenized using a mill with a 1 mm sieve. The contents of crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), acid detergent protein (ADP), phosphorus (P), potassium (K), calcium (Ca), and magnesium (Mg) were analyzed using a Foss NIR Systems Model 6500 Win ISI II v1.5 NIRS instrument. Dry matter intake (DMI), digestible dry matter (DDM), relative feed value (RFV), digestible energy (DE), and metabolic energy (ME) were calculated from ADF and NDF values using the following equations from the literature:

Digestible Dry Matter (DDM) = 88.9 - (0.779 x %ADF) (Oddy et al. 1983)

Dry Matter Intake (DMI) = 120 / (%NDF) (Sheaffer et al. 1995)

Relative Feed Value (RFV) = (DDM x DMI) / 1.29 (Sheaffer et al. 1995)

Digestible Energy (DE) = 0.27 + 0.0428 x (%DDM) (Fonnesbeck et al. 1984)

Metabolizable Energy (ME) = 0.821 x DE (Mcal/kg) (Khalil et al. 1986)

Finally, Ca/P and K/(Ca+Mg) ratios were calculated to evaluate the relationships among macro element contents.

Statistical analysis

Data pertaining to the parameters examined in this study were analyzed using analysis of variance (ANOVA) with the JMP 13 statistical software package. Significant differences among years identified by ANOVA were determined using the Least Significant Difference (LSD) multiple comparison test ($p<0.05$).

RESULTS AND DISCUSSION

Nutrient composition data obtained from the two-year analysis of grass samples collected from Sal Pasture are presented in Table 1. These analyses reveal the overall nutritional quality of the pasture's grasses and potential variations between years.

Table 1. Yield and nutritional value of Sal Plateau pasture

Features Analyzed	1. Year	2. Year	Average
Fresh Yield (FY) (kg/da)	748±18.83 a	695±31.89 b	721
Dry Yield (DY) (kg/da)	164±6.86 a	152±12.55 b	158
Crude Protein (CP) (%)	13.17±0.28	13.36±0.84	13.27
Acid Detergent Fiber (ADF) (%)	37.79±4.07	36.99±2.49	37.39
Neutral Detergent Fiber (NDF) (%)	65.17±4.10	64.66±3.48	64.92
Acid Detergent Protein (ADP) (%)	1.43±0.16	1.41±0.12	1.42
Digestible Dry Matter (DDM) (%)	59.46±3.17	60.08±1.94	59.77
Dry Matter Intake (DMI) (%)	1.84±0.12	1.86±0.10	1.85
Relative Feed Value (RFV)	84.88±10.37	86.44±7.67	85.66
Digestible Energy (DE) (Mcal/kg)	2.81±0.08	2.84±0.14	2.83
Metabolic Energy (ME) (Mcal/kg)	2.31±0.07	2.33±0.11	2.32
Phosphorus (P) (%)	0.21±0.05	0.23±0.06	0.22
Potassium (K) (%)	1.48±0.17	1.37±0.10	1,43
Calcium (Ca) (%)	1.44±0.11	1.50±0.21	1.47
Magnesium (Mg) (%)	0.38±0.08	0.40±0.09	0.39
Ca/P	6.55±1.11	6.82±1.26	6.68
K/(Ca+Mg)	0.81±0.06 a	0.72±0.02 b	0.77

The nutritional characteristics of forage samples collected from Sal Plateau pasture were assessed over two consecutive years, and the results are presented in Table 1. The average fresh yield was determined to be 721 kg/da. A statistically significant difference ($p<0.05$) was observed in fresh yield between the two years, with the first year exhibiting a higher yield (748 kg/da) compared to the second year (695 kg/da). This inter-annual variation in fresh yield could be attributed to fluctuating environmental factors such as precipitation and temperature. The average dry matter yield, which represents the dry matter available for consumption by grazing animals, was 158 kg/da. Similar to fresh yield, a statistically significant difference ($p<0.05$) was found in dry yield between the two years, with the first year showing a higher value (164 kg/da) than the second year (152 kg/da).

The average crude protein (CP) content, a key indicator of forage nutritional value, was 13.27%. This value suggests a moderate to good protein content in the Sal Plateau pasture. Fiber content, represented by acid detergent fiber (ADF) and neutral detergent fiber (NDF), averaged 37.39% and 64.92%, respectively. ADF, which is negatively correlated with digestibility, indicates a relatively good digestibility potential of the forage. NDF, which influences feed intake, suggests a moderate intake potential. The average acid detergent protein (ADP) content was 1.42%.

Digestible dry matter (DDM) averaged 59.77%, indicating the proportion of dry matter available for digestion by ruminant animals. Dry matter intake (DMI), an estimate of voluntary feed intake, averaged 1.85%. The relative feed value (RFV), a comprehensive index combining digestibility and intake potential, averaged 85.66. Digestible energy (DE) and metabolic energy (ME) averaged 2.83 Mcal/kg and 2.32 Mcal/kg, respectively, providing valuable information on the energy content of the forage.

The average mineral contents were as follows: phosphorus (P), 0.22%; potassium (K), 1.43%; calcium (Ca), 1.47%; and magnesium (Mg), 0.39%. These mineral concentrations are essential for various physiological functions in grazing animals. The calcium to phosphorus (Ca/P) ratio averaged 6.68, which is within the desirable range for ruminant nutrition. A statistically significant difference ($p<0.05$) was found between the two years for the potassium to calcium plus magnesium [K/(Ca+Mg)] ratio, with the first year showing a higher value (0.81±0.06) than the second year (0.72±0.02). This difference could be related to changes in plant species composition or soil nutrient availability between the years.

This study evaluated the nutritional characteristics of forage samples collected from Sal Plateau pasture over two years. The findings were compared with previous research conducted in different regions of Türkiye to provide a broader context and identify potential regional variations in pasture quality.

Regarding dry matter yield (DY), the average value obtained in this study (158.24 kg/da) was considerably lower than the value reported by Kılıç (2018) for Beypınarı pasture in Trabzon (827.3 kg/da). This substantial difference in DY could be attributed to several factors, including variations in climatic conditions (precipitation, temperature, solar radiation), soil properties (nutrient availability, soil type), botanical composition (dominant plant species), and grazing management practices between the two locations. Sal Plateau, being a high-altitude pasture, may experience shorter growing seasons and harsher environmental conditions compared to the lower-altitude Beypınarı pasture, thus influencing biomass production.

The average crude protein (CP) content in Sal Plateau pasture (13.27%) fell within the range reported in several studies. While it was lower than the values reported by Şahinoğlu (2010) for Bafra pasture (16.33-18.64%), Nadir (2010) for Tokat pasture (16.48-18.81%), Kokten et al. (2010) in Anti-Taurus Mountain rangeland shrubs (5.9-23.1%), Çaçan and Kökten (2014) for Bingöl pasture (16.08%), Aydın and Başbağ (2017) for Karacadağ pastures (19.19%) and Kökten and Tanrıverdi (2020) for Muş pasture (14.37%), it was comparable to the range observed by Güllap (2010) in Erzurum pastures (8.26-13.12%), Parlak et al. (2015) in Çanakkale pastures (9.10-13.18%), Taşdemir and Kökten (2015) in Elazığ pasture (12.2%), Cacan and Kokten (2019) in Bingol pasture (12.8-14.1%). This variability in CP content across different regions highlights the influence of local environmental conditions and plant species composition on forage protein levels.

Fiber components, as measured by acid detergent fiber (ADF) and neutral detergent fiber (NDF), play a crucial role in determining forage digestibility and intake. The average ADF (37.39%) and NDF (64.92%) values obtained in this study were generally higher than those reported by Şahinoğlu (2010) (ADF: 29.82-31.99%; NDF: 46.39-55.21%), Nadir (2010) (ADF: 24.38-26.84%; NDF: 34.59-36.32%), and Aydın and Başbağ (2017) (ADF: 29.78%; NDF: 47.76%). However, the ADF values were similar to those reported by Tutar and Kökten (2019) (34.8-37.4%) in Bingöl. The NDF value was also similar to the upper range of values observed by Tutar and Kökten (2019) (52.5-62.7%) and Güllap (2010) (43.57-50.28%). Higher ADF and NDF values generally indicate lower digestibility and potentially reduced feed intake by grazing animals.

The relative feed value (RFV), a comprehensive index combining digestibility and intake potential, was 85.66 in this study. This value was substantially lower than the RFV values reported by Nadir (2010) (174.96-189.77), Taşdemir and Kökten (2015) (103.0-118.4), Aydın and Başbağ (2017) (137.7) and Kökten and Tanrıverdi (2020) (102.0-112.5), but closer to the values found by Tutar and Kökten (2019) (91.8-109.4) and Cacan and Kokten (2019) (85.0-92.8). This difference in RFV further emphasizes the regional variation in forage quality and its implications for animal performance.

Regarding mineral content, the phosphorus (P) content of Sal Plateau pasture (0.22%) was lower compared to the values reported by Şahinoğlu (2010) (0.40-0.43%), Aydın and Başbağ (2017) (0.34%), Kökten and Taşdemir (2023) (0.34-0.39%) and Saygın and Kokten (2024) (0.26%). Potassium (K) content (1.43%) was lower than the values reported by Şahinoğlu (2010) (2.32-2.60%), Aydın and Başbağ (2017) (2.42%), Çaçan and Kökten (2023) (24.1%), Kökten and Taşdemir (2023) (2.44-3.00%) and Saygın and Kokten (2024) (1.51%). Calcium (Ca) content (1.47%) was higher than the range reported by Şahinoğlu (2010) (0.90-1.33%), Çaçan and Kökten (2023) (1.14%), Kökten and Taşdemir (2023) (1.06-1.20%) and Saygın and Kokten (2024) (1.21%), but comparable to Aydın and Başbağ (2017) (1.09%). Magnesium (Mg) content (0.39%) was slightly higher than the range found by Şahinoğlu (2010) (0.26-0.36%), Kökten and Taşdemir (2023) (0.26-0.33%) and similar to Aydın and Başbağ (2017) (0.31%) and Saygın and Kokten (2024) (0.31%). The K/(Ca+Mg) ratio (0.77) was considerably lower than those reported by Şahinoğlu (2010) (1.61-2.13%), with a statistically significant difference ($p<0.05$) between the two years of the present study. These differences in mineral content could be related to soil mineral composition, plant species, and environmental factors.

The mineral analysis conducted on the Sal Plateau pasture revealed that the average phosphorus (P) content (0.22%) was insufficient for animal nutrition. Conversely, the average potassium (K) content (1.43%) and magnesium (Mg) content (0.39%) were found to be adequate for meeting animal requirements. The average calcium (Ca) content (1.47%) was also determined to be sufficient. However, the average Ca/P ratio (6.68) indicated an imbalanced mineral proportion, which could potentially lead to bone development issues in animals. The average K/(Ca+Mg) ratio (0.77) suggested a low risk of tetany. Nevertheless, the observed phosphorus deficiency and imbalanced Ca/P ratio highlight the necessity for mineral supplementation or fertilization to improve the mineral composition of the pasture.

In conclusion, the nutritional quality of Sal Plateau pasture, as assessed in this study, exhibited some differences compared to other regions of Türkiye. While CP content was comparable to some studies, DY and RFV were generally lower, suggesting potential limitations in biomass production and overall forage quality. The observed inter-annual variations in certain parameters highlight the importance of considering environmental factors and implementing appropriate grazing management strategies to optimize pasture productivity and nutritional value for grazing livestock.

CONCLUSION

This study comprehensively assessed the forage quality and yield of Sal Pasture in Rize, Türkiye, revealing valuable insights into its nutritional potential for livestock grazing. The observed inter-annual variability in fresh and dry matter yields underscores the influence of climatic factors on pasture productivity. While the crude protein content indicated a moderate nutritional value, the fiber fractions (ADF and NDF) and digestibility parameters (DDM, DE, ME) provided a detailed understanding of the forage's quality. Mineral analyses highlighted specific areas of concern. The phosphorus content was notably low, suggesting a potential deficiency for grazing animals. Conversely, potassium, calcium, and magnesium levels were found to be adequate. The Ca/P ratio indicated a mineral imbalance that could impact animal health, while the K/(Ca+Mg) ratio suggested a low risk of tetany. The

significant inter-annual variation in the K/(Ca+Mg) ratio further emphasizes the dynamic nature of pasture mineral composition. These findings suggest that while Sal Pasture offers valuable forage resources, strategic interventions such as mineral supplementation or targeted fertilization may be necessary to optimize its nutritional value and ensure the health and productivity of grazing livestock. Future research should focus on long-term monitoring of pasture dynamics and the development of sustainable management practices to enhance forage quality and yield in this unique ecosystem.

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. The author verifies that the Text, Figures, and Tables are original and that they have not been published before.

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