



Changes in Feed Quality among Rangeland Sites Grazed by Different Livestock Species

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ABSTRACT

Rangelands provide valuable feed for livestock industry but the quality of feed changes among both season and plant composition. Grazing is the most important factor shaping plant composition. This study was conducted in the Umudum district of Erzurum province in 2023. In the study, three different rangeland sites, which grazed different livestock herds (only cattle, cattle + sheep, and only sheep), were examined. The study investigated available forage amounts and its some feed quality properties on the rangelands sites. The investigated parameters are amount of available forage, crude protein, NDF, ADF ratios, and RFV values. It was observed that the rangeland site grazed by only sheep herds had lowest available forage and feed quantity properties such as crude protein ratio, and RFV compared to the sites grazed by only cattle and cattle + sheep herds, whereas it had higher NDF and ADF in the sites grazed by sheep herd. The results showed that single sheep herds, which grazed uncontrolled, have the detrimental effect on forage quality by cause decreasing valuable plant species in botanical composition.

1. Introduction

Grazing is an important environmental factor that shapes the rangeland plant cover and structure in a particular area, however, grazing effect changes depending on size, breed and genus of the grazing animal. In general, cattle prefer grasses and leave 3-4 cm stubble while sheep utilize forbs efficiently and leave less than 1 cm stubble (Altın et al., 2011). Therefore, detrimental effect of sheep herds is more pronounced under heavy grazing pressure. Grazing pressure can be understand easily estimating available forage on the grazing area. As grazing pressure increase, available forage get decrease (Güllap, 2010; Yu et al., 2024).

Additionally, while moderate grazing is a necessary factor for sustainable production, over grazing practices have had adverse effects on production, the condition and health of rangelands (Koç and Gökkuş, 1994; Çomaklı et al., 2012;

Aydoğdu et al., 2020; Gökkuş, 2020). Grazing has been reported to both reduce plant species diversity in dry forest areas (Schulz et al., 2019) and enhance plant species diversity in grazed rangeland sites (Gonzalez-Hernandez et al., 2020). The positive and negative effects of heavy, moderate, and light grazing on plant species diversity and production have been identified in many studies (McNaughton, 1983; Cardinale et al., 2012).

Heavy grazing has been reported to decrease the plant and shrub diversity in rangeland areas (Zhao et al., 2006), with some species disappearing while others persist based on morphological or physiological characteristics (Wang et al., 2002). If herd sizes remain constant and grazing areas continuously decrease, the plant species diversity decreases with grazing levels dropping (Haynes et al., 2013). In contrast, light and moderate grazing have been shown to increase plant diversity by reducing the dominance of any particular plant species and suppressing others (SRM, 2003). The

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potential impact of grazing intensity varies significantly depending on animal size and grazing habits (Yunusbaev et al., 2003; Altın et al., 2011; Erkovan, 2016). Cattle prefer to graze on taller plants, using their tongues to pull in to mouth and cut plants with a minimum height of 5-6 cm. Additionally, cattle, having a higher capacity for consuming grass and seeds compared to small ruminants, contribute significantly to the change in plant composition by allowing the spread of seeds through their dung (Bakker and Olff, 2003). Sheep, on the other hand, have slender, mobile lips and selectively bite plants and shoots, grazing on single leaves with a height of 3 cm when conditions permit. Compared to cattle, sheep are observed to be more selective in their grazing habits, showing a preference for forbs which are untasted for cattle (Rose et al., 2012).

Livestock grazing has a significant impact on the soil, and this effect is largely associated with the reduction of vegetation cover in rangelands (Oztas et al., 2003; Monaghan et al., 2017; Abdalla et al., 2018). Intensive grazing in rangelands leads to a considerable deterioration of soil physical properties such as permeability, infiltration, pore volume and function, bulk density, and structural aggregation (Monaghan et al., 2017; Laurenson et al., 2018). The degree of soil disturbance during grazing in rangelands varies significantly depending on factors such as hoof pressure (Greenwood and McKenzie, 2001; Hu et al., 2018), grazing duration (Drewry et al., 2003), and the history of previous grazing events (Cournane et al., 2011). Additionally, as a result of grazing, significant increases can occur not only in the volume weight of the soil but also in the pH value (Evans et al., 2012). This effect may vary based on the intensity of grazing and the moisture content of the soil (Çetiner et al., 2012; Lenssen et al., 2013). Grazing different types of livestock on rangelands can also impact soil properties to varying degrees. Cattle, despite being heavier than sheep and exerting more pressure on the soil, may contribute to better soil conditions in the grazed areas due to their less intensive trampling (Erkovan et al., 2016).

In various district across Turkey and particularly in the Eastern Anatolia Region, which constitutes 34.8% of our country's rangeland areas, numerous studies have been conducted on rangelands (Yavuz et al., 2012; Çınar et al., 2014; Ünal et al., 2014; Çomaklı et al., 2015; Uzun et al., 2015; Alay et al., 2016; Erkovan et al., 2016; Koç

and İleri, 2016; Reis and Şen, 2017; Seydoşoğlu et al., 2018). However, upto date, no study has been conducted on grazing sites involving single herd or mixed grazing. Therefore, this study aims to determine the effects of grazing practiced different livestock species on the forage quality of rangelands. Additionally, based on the data obtained, efforts will be made to develop rangeland management plans suitable for each type of livestock.

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2. Materials and Methods

The study was conducted in the Umudum district of Yakutiye town of Erzurum Province, in the year of 2023. Three rangelands site where was similar to each other grazed with different herds was selected the total rangeland area in Umudum district 3. 281 ha, with a livestock population of 2.797 cattle and 100 sheep LSU. Vegetation survey were carried out during the flowering stage of common plants in the second week of July (Gökkuş et al., 2000). The rangeland sites and their using practices are given in the Table 1.

Erzurum has a continental climate and long-term average temperature is 5.6 °C and precipitation is 429 mm. Winters are generally cold and snowy, while summers are hot and dry. Although the research was conducted in 2023, presented the years of 2022 climate data because autumn precipitation of previous year had significant impact on rangeland vegetation (Koç, 2001). The humidity, temperature, and relative humidity values for that years are shown in Figure 1. In the year 2023 when the study was conducted, it was determined that the recorded temperature value (7,89 °C) were higher than the long-term average temperature value (5,75 °C). The highest

temperature recorded in the year of the study occurred in August. The lowest temperature recorded in the year 2023 was -7,9 °C in February,

while the lowest temperature recorded in the long-term average was -9,1 °C in January (Figure 1).

Table 1. Grazing practices and size of the rangeland sites

Rangeland site I	In this rangeland site are grazed by only cattle herd, and the allocated area is approximately 1.881 ha. The Herd size is average 2.797 Livestock unit (LU). Allocated area per LU is 0,67 ha.
Rangeland site II	In this rangeland site are grazed by mixed herd of cattle and sheep and the allocated area is approximately 1.300 ha. The herd size is average 2.897 LU. Allocated area per LU is 0,45 ha
Rangeland site III	In this rangeland site grazed by only sheep herd, and the allocated area is approximately 100 ha. The herd size is about 100 LU. Allocated area per LU is 1 ha

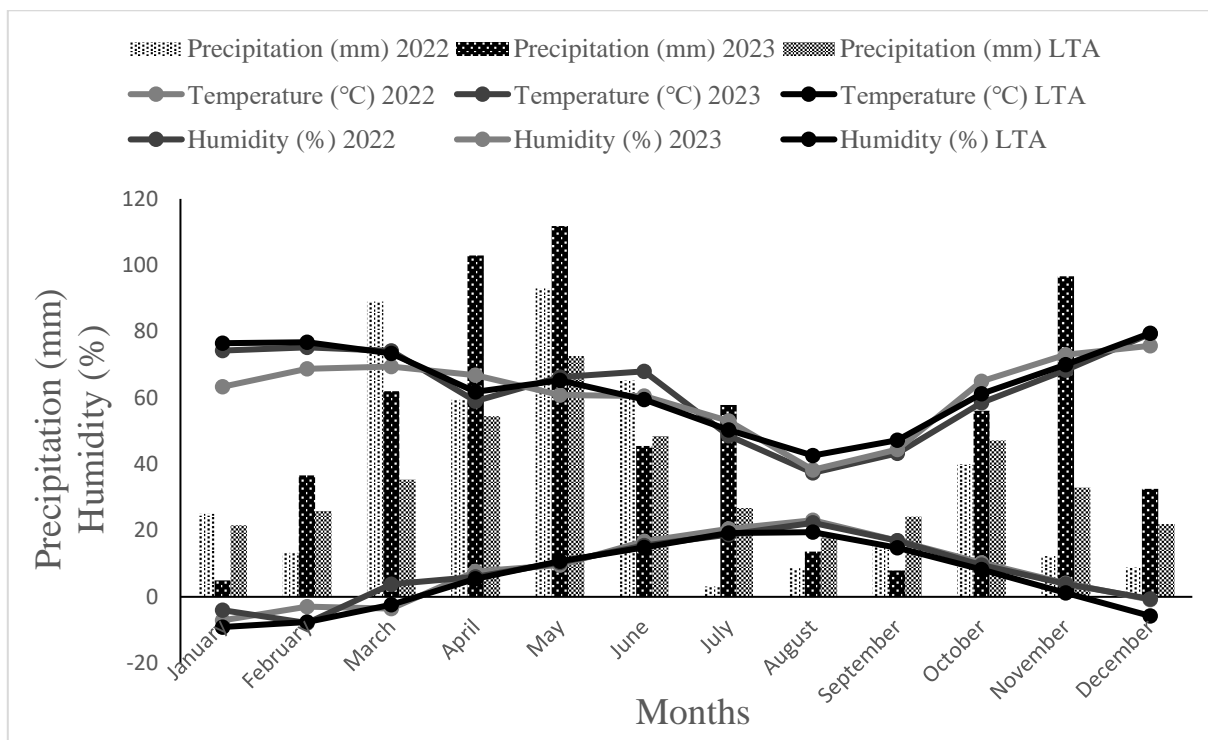


Figure 1. Some climate data of Yakutiye District of Erzurum Province in 2022, 2023, and long-term average (LTA).

The recorded relative humidity values for long term average and observed years were 62,7%, 61,60%, and 63,70%, respectively. While relative humidity was higher during cold months; it was lower during hot summer months. In the experimental year, the total annual precipitation was higher (mm) than long term average (429 mm) (Figure 1).

According to the soil samples taken from the study area, the texture classes of the three-rangeland site I, II and III were recorded as clay-loam, clay-loam, and sandy-loam, respectively (Ergene, 1993). Among the rangeland sites, site I had the highest aggregate stability at 66,28%, while site III had the lowest aggregate stability at 24,23% (Demiralay, 1993). Soil pH of the all sites indicated a slightly acidic character (Sağlam, 1994). The

electrical conductivity (EC) values determined in the rangeland sites ranged between 0,171 and 0,224, suggesting that there is no issue with salinity (Richards, 1954). The organic matter content in the soils taken from rangeland sites showed variations between 1,39% and 5,36%, with the rangeland site grazed by cattle having a higher organic matter content (Aydın and Sezen, 1995). The content of plant available phosphorus was determined based on the method stated by Olsen and Summer (1982), it was found to be 82,5 kg ha⁻¹ in the rangeland site I, 63.2 kg ha⁻¹ in the site II, and 32,5 kg ha⁻¹ in the site III. The potassium (K), sodium (Na), and calcium (Ca) contents of the three different rangeland sites, determined based on the method established by Sağlam (1994), showed variations in the ranges of 1,24-1,63 me 100⁻¹, 0,08-0,15 me 100⁻¹

¹, and 3,43-4,20 me 100⁻¹, respectively. Variance was first applied to the values obtained from the pasture sections in the SPSS package programme and then Duncan multiple comparison test was used to compare the values (Yıldız and Bircan, 1994).

3. Results and Discussion

The amount of available forage

The amounts of available forage amount are recorded as 982,7 kg ha⁻¹, 641,8 kg ha⁻¹, and 312,0 kg ha⁻¹ for the rangeland site I, II and III, respectively.

Grazing livestock generally rely on their senses of touch, sight, and smell when selecting their food. Livestock feeding in this manner prioritizes young leaves, older leaves, green stems, and finally, older stems in terms of preference. However, significant differences exist in grazing behavior among different livestock species. For instance, sheep tend to be more selective, generally preferring legumes and other plant species with high palatability

(Harper, 1977; Hodgson, 1990; Rose et al., 2012; Erkovan et al., 2016). Despite not being able to grasp and wrap around plants effectively due to their split upper lips, sheep engage in grazing close to the soil surface (Çavuşoğlu and Akyürek, 2017). In conclusion, sheep are likely to leave less residue compared to cattle in areas grazed by sheep, as they are more selective in their foraging habits (Sanon et al., 2007; Rose et al., 2012; Erkovan et al., 2016). Additionally, in areas where small ruminants graze, they may have smaller spatial coverage compared to other types of grazed areas (Table 1). Despite smaller body sizes and lower pressure applied per unit area compared to large ruminants, small ruminants, especially sheep, may move more extensively in the rangeland (Golodets and Boeken 2006; Sydes and Miller 1988; Vickery et al., 2001; Li et al., 2008). In addition to all these factors, it is thought that the heavy grazing of the area from the past to the present also has an effect, and especially the bottom grazing of sheep (Erkovan et al., 2016) is also thought to be effective in the formation of such a difference between rangeland sections.

Table 2. The amount of available forage and variance analysis results of rangeland sites grazed by different livestock species

The amount of available forage (kg ha ⁻¹)	Rangeland Sites				
	Site I	Site II	Site III	Average	F Value
	982,7 A	641,8 B	312,0 C	645,5	58,940**

** significant F value at 1%, * significant F value at 5%. ns: non-significant

Crude protein ratio

The crude protein ratios determined in site I, II and III are 14,26, 11,9%, and 9,00%, respectively. The difference among them has shown significance at the 1% significance level (Table 3).

The observed difference in crude protein ratios among rangeland sites may be attributed to the presence of different livestock species in each site. Specifically, sheep, due to their unique mouth structure (Koyuncu and Tuncel, 2010), tend to be more selective grazers compared to cattle and they preferentially graze leaves and forbs especially legumes which have higher crude protein content (Bakır, 1987; Grace et al., 2002; Altın et al., 2011; Rose et al., 2012; Koç and İleri, 2016).

Consequently, ungrazed residues which presented as available forage had lower as sheep density increase in the sites.

NDF ratio

The Neutral Detergent Fiber (NDF) ratio, consisting of cellulose, lignin, and hemicellulose (Rayburn, 2004), was determined to be an average of 51,34% and it changed between 44,79 and 56,52 % among the rangeland sites (Table 4). The observed difference in NDF ratios among rangeland sites may be attributed to the general preference of sheep for plants with high energy value and nitrogen content and low cellulose content in the botanical composition (Ünal and Akçapınar, 1994).

Table 3. Crude protein ratios and variance analysis results of rangeland sites grazed by different livestock species

Crude protein ratio (%)	Rangeland Sites				
	Site I	Site II	Site III	Average	F Value
	14,26 A	11,97 B	9,00 C	11,74	74,442 **

** significant F value at 1%, * significant F value at 5%. ns: non-significant

Table 4. NDF ratios and variance analysis results of rangeland sites grazed by different livestock species

NDF (%)	Rangeland Sites				
	Site I	Site II	Site III	Average	F Value
	44,79 C	52,71 B	56,52 A	51,34	97,682**

** significant F value at 1%, * significant F value at 5%. ns: non-significant

Indeed, the findings of our study are in line with similar research (Bilgen and Özyiğit, 2005; Erkovan et al., 2016; Çavuşoğlu and Akyürek, 2017; Çelik, 2019) that indicates a decrease in legumes sensitive to grazing (Çomaklı et al., 2021) with sheep grazing. Additionally, the results obtained in our study regarding the NDF ratios parallel the findings of Aydın et al., 2014 (46,59-47,69%), Çağan et al., 2014 (43,31-50,86%), Özaslan Parlak et al., 2015 (43,18-51,57%), and Taşdemir, 2015 (49,00-56,00%).

ADF ratio

The Acid Detergent Fiber (ADF) ratio, consisting of structural carbohydrates and including cellulose-lignin (Anonymous, 2011), has varied between 36,33% and 42,07% in areas grazed by different types of animals. The ADF ratio determined in the study, with a value of 36,33%, is noted to be lower in areas grazed by cattle compared to areas grazed by sheep with a ratio of 42,07% (Table 5).

The observed variation in ADF ratio in the study, as evident from the examination of Table 5, may be due to the different intensities and livestock species grazing among the rangeland sites. Because intensive grazing can lead to a reduction in rangeland cover and height, it consequently results in a decrease in rangeland site productivity and a significant decline in particularly palatable

livestock species that contribute to the botanical composition (Zhang et al., 2006). Intensive grazing by sheep can lead to a decrease in the amount of forage consumed by livestock, increasing the need for nutrients that provide high levels of energy for livestock to be adequately nourished. Because sheep tend to be more selective grazers compared to cattle (Spedding, 1965; Karşlı and Küçük, 2000; Glindemann et al., 2009; Erkovan et al., 2016; Koç and İleri, 2016) and they choose more palatable legumes and other family species (Traczyk and Kotowska, 1976; Losvik, 1993; Bakoğlu, 1999; Rose et al., 2012; Erkovan et al., 2016), it seems likely that in the studied rangeland site, where high-quality vegetation cover is lacking due to intensive sheep grazing, the ADF ratio is higher in areas grazed by sheep.

Relative feed value (RFV)

The Relative feed value (RFV), determined based on the digestion and consumption of dry matter, has been found to vary between 93,10 and 125,84 among the rangeland sites.

This value, which varies according to plant composition and plant parts, it decreases with the increase in ADF and NDF ratios (Canbolat and Karaman, 2009; Temel et al., 2015; Gürsoy and Macit, 2017; Tan et al., 2019). The results consisted with the NDF and ADF content of the hay obtained from the sites.

Table 5. ADF ratios and variance analysis results of rangeland sites grazed by different livestock species

ADF (%)	Rangeland Sites				
	Site I	Site II	Site III	Average	F Value
	36,33 B	39,68 A	42,07 A	39,36	7,013**

** significant F value at 1%, * significant F value at 5%. ns: non-significant

Table 6. Relative feed value (RFV) and variance analysis results of rangeland sites grazed by different livestock species

RFV	Rangeland Sites				
	Site I	Site II	Site III	Site I	F Value
	125,84 A	102,48 B	93,10 C	107,14	71,759**

** significant F value at 1%, * significant F value at 5%. ns: non-significant

4. Conclusions

When the results obtained from the rangeland sections grazed by different breeds of animals were evaluated as a whole, it was noted that especially the rangeland section grazed by sheep exhibited a

very bad trend in terms of both the amount of available forage obtained and forage quality compared to the other sections. In addition, significant decreases in feed quality were determined in the pasture section where cattle and

sheep were grazed together, and it is thought that the preference of sheep for broad-leaved plant species in general has an important effect. When an evaluation is made in terms of erosion in the pasture sections where the study was carried out, we can say that the section grazed by cattle has a very low erosion risk compared to the other sections. To summaries the study, it should never be ignored that sheep and cattle should be grazed in a controlled manner in mixed grazing in order to ensure that the rangeland are not grazed above their capacity and that the species components show a proper distribution in terms of a sustainable pasture. In addition, it is very important in terms of rangeland management to graze with the animal species suitable for the type of rangeland in the grazing season in order not to spoil the structure of the pasture and to get the maximum yield from the rangeland.

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