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Changes in Botanical Composition of Rangeland Sites Grazed at Different Intensities

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A B S T R A C T

The study was conducted in Köşk and Büyükdere districts, which belong to Yakutiye and Pasinler districts of Erzurum province, where grazing is practised at three different intensities (light, moderate and heavy). The study was conducted in 2022 and analysed the botanical composition, soil cover, pasture condition score and pasture condition and health class. In the study, the difference between grasses and other family ratios in botanical composition, excluding the legume ratio, was statistically significant. It was found that an increase in grazing intensity led to a decrease in ground cover ratio and range condition score. In addition, differences in pasture condition and health class were observed between pasture sites grazed at different intensities.

1. Introduction

In addition to their value for livestock production, rangelands also provide important performance in terms of environmental and ecological functions. Rangelands host rich biological diversity, including flora, fauna, microorganisms, and various ecosystems, with environmental, economic, cultural, and scientific significance. Despite their vulnerability to droughts, many rangelands are integral parts of large basins and drainage systems, playing a crucial role in hydrological cycles. When managed sustainably, rangelands are reported to have a significant impact on reducing vegetation runoff, preventing water infiltration, increasing soil moisture, recharging groundwater resources, and reducing the risk of natural disasters such as floods and droughts (IUCN, 2015). Thus, it is stated that meadow and rangeland areas will provide very important contributions to keeping the emission of greenhouse gases that cause drought and climate change, which are the most fundamental problems of today, at a certain level (Tanrıvermiş and Erkul, 2008).

The ecology of rangelands differs significantly from that of other biomes, especially forests. The ecology of these regions is determined by various factors such as drought, temperature, seasonality, fire incidence and dependence on grazing species. In this model, rangeland vegetation and ecological communities respond in complex ways to different pressures, including natural events such as grazing, drought and fire. Plants in drylands have co-evolved with grazing species over millions of years and have become dependent on the activities of grazers to maintain plant health (Frank et al., 1998; McNaughton, 1983). Grazing stabilizes grassland ecosystems, while the absence of grazing destabilizes the system (Perevolotsky and Seligman, 1998). However, as a result of unconscious early and excessive grazing in rangeland-based livestock farming areas, the climax vegetation is physiologically damaged, the composition of the vegetation changes, good species of rangeland plants are lost, and as a result, plant species that are less preferred or not grazed at all become dominant in rangelands (Gençkan, 1992; Sürmen and Kara 2008).

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Considering the Mediterranean climate zone in which our country is located, it is observed that the livestocks are inadequately fed because the rangelands are overgrazed, 87.6% of the rangelands of our country are in moderate and poor condition (Avağ et al., 2012) and supplementary feeding is applied. As a matter of fact, many studies (Koç 1995; Bakoğlu 1999; Erkovan 2000; Sürmen 2004; Güllap 2010; Çomaklı et al. 2012; Severoğlu 2018) conducted in Erzurum province, which is located in the Eastern Anatolia Region, which has large rangeland areas in our country, have stated that excessive and untimely grazing causes serious degradation and reduction in rangeland areas.

However, although many negative effects of early and overgrazing on rangelands have been mentioned in the studies so far, no study has been conducted on the botanical composition change in rangelands depending on grazing intensity. Therefore, in this study, it was tried to reveal which grazing systems would be more suitable for the sustainability of rangelands by examining how the existing botanical composition in rangeland sites exposed to three different grazing intensities (light, moderate and heavy) responds to grazing intensities.

2. Materials and Methods

The study was carried out in three different (light, moderate and intensive) intensively grazed rangeland sites in Köşk and Büyükdere neighborhoods of Yakutiye and Pasinler Districts of Erzurum Province. Information about the rangeland sites where the study was conducted is briefly summarized in Table 1.

Table 1. Information on rangeland sites

Rangeland sites	Characteristics
I. (Light)	This site, which is used by the Köşk neighborhood itself, was determined as the study area. This site has a total of 8977.76 ha of rangeland and a total of 3305 livestocks, including 1388 cattle and 1917 sheep, graze in this area. Its value in Livestock Unit (LSU) is 1579.7. However, considering the livestock population of the village, 144.62 ha was rented and the total rangeland area of the village became 8833.14 ha. In other words, 1597.7 LSU graze on an area of 8833.14 ha in this rangeland site. The altitude of this rangeland site is around 2246 m.
II. (Moderate)	The rangeland site rented from Köşk village pasture was determined as the study area. This site is 144.62 ha, and if it is taken into consideration that the person leasing here also has his own 150 ha area, 1070 sheep graze on a total area of 294.62 ha. The number of sheeps grazed in this site is 107 in LSU. The altitude of this rangeland site is around 2610 m.
III. (Intensive)	Büyükdere Neighborhood, which borders Köşk Neighborhood, has a total of 3749.62 ha of rangeland and 1340.10 ha of this area is rented for 2870 sheep and this area was determined as the study area. However, considering that approximately 15,000 thousand small cattle enter this area, approximately 17,870 small cattle grazes in this area. The total number of small cattle grazed in this area is 1787 in LSU. The altitude of this rangeland site is around 2780 m.

When the capacities of the rangeland areas given in Table 1 for one grazing season are calculated; it is calculated that the first rangeland site has an area of 55.89 da for one grazing season with 1579.7 LSU. In the study, it was determined that the second rangeland site had an area of 27.53 da for one grazing season with 107.0 LSU. And, in the study, it was calculated that the third rangeland site had an area of 7.5 da for one grazing season with 1787 LSU. Considering that an area of 40 ha in LSU (Altın et al., 2011; Çomaklı et al., 2012) is needed for one grazing season, rangeland sites were classified as lightly, moderately and heavily grazed.

Erzurum Province, which has very cold and snowy winters and very hot and dry summers, is covered with snow for almost 2-3 months of the year. Although the year of the study was 2022, since the current botanical composition is likely to be affected by the fall precipitation in the previous year (Koç, 2001), precipitation, temperature and humidity rates for 2021 were also given (Table 2). The average temperature value recorded in 2022 was 7.9°C, which was higher than the previous year (7.1°C) and the long-term average (6.7°C). In 2022,

the lowest temperature value was -7.1°C (January) and the highest temperature value was 23.1°C (August). Relative humidity, which was 65.2% on average for many years, was 62.8% in 2021 and 62.1% in 2022. The highest relative humidity was determined in December (79.3%) and the lowest relative humidity was determined in August (37.39%). The total annual precipitation in 2022 was 496.3 mm, the highest precipitation was 104.5 mm in May and the lowest precipitation was 2.3 mm in July (Table 2).

Table 2. Some climatic values of Erzurum province for 2021 and 2022 and long-term average

Months	Monthly Average Temperature (^{0}C)			Monthly Average Relative Humidity (%)			Monthly Total Precipitation (mm)		
	2021	2022	Long term Average	2021	2022	Long term Average	2021	2022	Long term Average
January	-7.4	-7.1	-8.1	78.8	74.3	78.6	14.3	35.3	24.8
February	-5	-3.0	-6.2	78.5	75.2	78.4	27.6	16.0	25.1
March	-2	-3.5	-0.2	75.1	74.2	72.6	66.8	103.4	44.6
April	8.9	7.7	6.3	56.3	59.0	64.5	13.4	65.9	62.3
May	13.4	9.6	11.1	49.8	66.3	64.3	32.8	104.5	78.3
June	17.5	16.7	15.9	44.0	60.8	58.2	16.0	75.0	42.2
July	20.6	20.5	19.9	47.4	48.6	51.9	15.4	2.3	24.0
August	20	23.1	20.6	48.5	37.39	47.9	25.8	5.0	21.2
September	14.2	16.9	15.4	53.3	43.3	51.1	31.6	16.0	21.5
October	7.1	10.3	9.0	64.5	58.49	64.0	60.6	43.6	51.3
November	2.5	4.1	1.6	76.7	68.4	71.5	29.8	18.3	28.0
December	-5.2	-0.8	-5.2	81.1	79.3	79.6	12.2	11.0	22.7
Total/Avg	7.1	7.9	6.7	62.8	62.1	65.2	346.3	496.3	446.1

In the three rangeland sites where the study was conducted, it was determined that the soil texture class varied between clay loam and sandy loam (Ergene, 1993). Aggregate stability was found to be 66.00%, 45.23% and 24.92% in light, moderate and heavy grazed areas, respectively (Demiralay, 1993). It was determined that the pH values determined in the sites in the study area varied between 6.10 and 6.48 and in general the sites were slightly acidic (Sağlam, 1994). In the study, it was recorded that there was no problem in terms of salinity in all three sites (Richards, 1954). In the rangeland sites, the lightly grazed site had the highest organic matter ratio with 5.42%, while the heavily grazed site had the lowest organic matter ratio with 1.33% (Aydın and Sezen 1995). According to the method determined by Olsen and Summer (1982), the amount of phosphorus available to the plant varied between sites by 3.19-8.18 kg/da. Based on the method determined by Sağlam (1994), it was determined that K contents in lightly, moderately and heavily grazed sites varied between 1.65 me/100 g, 1.36 me/100 g and 1.20 me/100 g, respectively, while Na contents varied between 0.16 me/100 g, 0.12 me/100 g and 0.9 me/100 g in lightly, moderately and heavily grazed sites, respectively. Also, based on the method determined by Sağlam (1994), it was determined that the Ca contents between the sites varied between 3.38 and 4, me/100 g and it was noted that these ratios would not cause Ca deficiency (Aydın and Sezen 1995) between the sites. The values obtained from 3 different rangeland sites were subjected to analysis of variance in SPSS package program and Duncan multiple comparison test was applied (Yıldız and Bircan, 1994).

3. Results and Discussion

Botanical composition

Grasses had an average of 26.34%, 34.77%, 29.84% and 14.40% of the vegetation cover in the lightly grazed, moderately grazed and heavily grazed areas, respectively. It was noted that the lightly grazed rangeland sites had a higher proportion of grasses compared to the other grazed sites. It was determined that the legume ratios, which was 18.75% on average, varied between 13.07% and 23.20% between rangeland sites. The proportions of species belonging to other families were 42.04% in the lightly grazed site, 50.16% in the moderate grazed site and 72.54% in the heavily grazed site (Table 3).

The difference in botanical composition among rangeland sites grazed at different intensities may

be influenced not only by the number of grazing livestock but also by the grazing preferences of the livestock. The fact that rangelands are richer and more homogeneous in terms of nutrients causes an increase in grazing pressure in these areas (Koç, 1995; Goss et al., 1998; Güllap, 2010; Çomaklı et al., 2012) and that the species diversity in these areas has changed as a result (Bobbink, 1991; Willems et al., 1993; Gough et al., 2000; Smith et al., 2000) is in parallel with our study. Similarly, many studies (Kruess and Tscharntke, 2002; Scimone et al., 2007; Wallis De Vries et al., 2007; Severoğlu, 2018) reported that grazing intensity significantly affects species components. In addition, since both sheep and cattle were grazed in the study, their feed preferences may have affected the change in botanical composition. As a matter of fact, Koç and Gökkuş, 1993 and Erkovan et al., 2016 stated that the differences in both the anatomical and physiological structure of the grazing livestock species significantly affect the species ratio in the botanical composition. Grazing habits and grazing intensities of grazing livestocks affect the continuous change of species composition in rangelands (Yunusbaev et al. 2003; Altın et al., 2011; Koç and İleri, 2016). This was also found in this study and it was determined that the heavily grazed area, especially the sheep grazed area, had a lower proportion of grasses compared to the lightly grazed area. Similarly, in many studies (Fırıncıoğlu et al., 2007; Chartier et al., 2009; Çelik, 2019), it was determined that intensive grazing caused significant reductions in the proportion of grasses.

Table 3. Species ratios in botanical composition of rangeland sites grazed at different intensities and analysis of variance results

Plant Species	Rangeland Sites				
	lightly grazed	moderately grazed	heavily grazed	Avg.	F values
Grasses (%)	34,77 a	29,84 ab	14,40 b	26,34	4,687*
Legumes (%)	23,20	20,00	13,07	18,75	2,706 ns
Other families (%)	42,04 B	50,16 B	72,54 A	54,91	7,786**

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

In the lightly, moderately and heavily grazed sites where the research was conducted, the proportion of legumes was 23.20%, 20.00% and 13.07%, respectively, which were higher in the lightly grazed site, but this difference between the sites was not statistically significant (Table 3). Grazing systems that are not in accordance with range management principles generally lead to the predominance of other families with low forage value and not preferred by livestocks (Erkovan 2000; Gökkuş and Koç 2001; Daşcı 2002; Öztaş et al. 2003; Güllap 2010; Severoğlu 2018). For this reason, it is expected that the rates of other families detected in the heavily grazed site of the study would be higher than the other sites. In addition to the fact that the area per livestock for a grazing season is less in the heavily grazed site as shown in Table 1, the fact that this site is at a higher altitude may have been effective in the high rate of undesirable species among the identified species. As a matter of fact, in many studies (Erkovan, 2000; Erkovan et al., 2003; Koç et al., 2008; Wassie et al., 2018), it was stated that the increase in altitude has a significant effect on the decrease in the proportion of quality species in the botanical composition, which is in line with the results obtained in our study.

Soil coverage rate (SCR)

In rangeland sites grazed at different intensities, the SCR ratios ranging between 65.40% and 24.60% was 65.40% in the lightly grazed site, 48.00% in the moderately grazed site and 24.60% in the heavily grazed site (Table 4).

As can be seen from the examination of Table 4 in the study, it is seen that the SCR rate decreases with increasing grazing pressure, in other words, there is an inverse relationship between grazing pressure and SCR. As a result of heavy grazing, especially in arid areas (Gökkuş, 2014), plants that cannot regenerate themselves weaken physiologically and this causes the places to remain empty (Çaçan et al., 2014). As a result of heavy grazing, both plant roots will be weakened and the organic matter and nitrogen content of soils will decrease, which will exacerbate vegetation and soil degradation (Han et al., 2008). In many studies (Koç 1995; Güllap 2010; Deng et al., 2014; Severoğlu, 2018; Mathewos et al., 2023), it was stated that the increase in grazing intensity

negatively affected the SCR rate. In addition, in the study, intensive grazing of sheep above its capacity in the heavily grazed rangeland site may be an important factor in the decrease in the SCR rate compared to other sites. Because although sheep are small in size and exert less rangeland on the soil than cattle (Golodets and Boeken 2006; Li et al. 2008), they move around the rangeland more and cause more bare soil surface ((Milton et al. 1997; Erkovan et al. 2016).

Table 4. Soil coverage ratios of rangeland sites grazed at different intensities and analysis of variance results

	Rangeland Sites				
	the lightly grazed	**moderately grazed**	**heavily grazed**	**Avg.**	**F values**
SCR (%)	65,40 A	48,00 B	24,60 C	46,00	15,851**

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

Rangeland condition score (RCS)

In this study, the RCS in the heavily grazed site (21.65) was lower than the RCS in the lightly grazed site (47.37), and in general, RCS decreased with increasing grazing intensity (Table 5).

We can say that such a difference in terms of RCS between the sites is due to the fact that the area allocated to livestock for a grazing season is lower, especially in the heavily grazed site, and sheep are grazed intensively. Because as a result of heavy grazing, the desirable species that are most preferred by livestock in botanical composition are lost and these species are replaced by species that are not preferred by livestock (Tsiouvaras et al., 1996; Allen-Diaz and Jackson, 2000; Tamartash et al., 2007; Güllap, 2010; Çomaklı et al., 2012). As a matter of fact, in many studies (Gür, 2014; Sürmen et al., 2015; Severoğlu, 2018; Nasiyev et al., 2022), it was stated that the difference in range quality grade was caused by grazing intensity and different utilization. In addition, the fact that sheep graze more selectively than cattle and prefer legumes and other high-quality family species (Rose et al. 2012; Erkovan et al. 2016) may be effective in the low RCS in the sheep grazed site in the study.

Table 5. Rangeland condition scores and analysis of variance results of rangeland sites grazed at different intensities

	Rangeland Sites				
	the lightly grazed	**moderately grazed**	**heavily grazed**	**Avg.**	**F values**
RCS	47,37 A	34,22 B	21,65 C	34,41	23,349**

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

Rangeland condition and health class

This situation, detected in the heavily grazed pasture section in the study, almost reflects the current situation of our country's rangeland. Because the rangelands of our country have lost almost 90% of their climax vegetation cover (Gençkan et al., 1990).

The grazing factor is one of the most important factors in the change of range vegetation cover and the increase in grazing intensity, especially in arid and semi-arid climates, causes the vegetation cover to deteriorate more quickly (Holechek and Pieper 1992). Therefore, this situation in the heavily grazed rangeland site may have been caused by excessive and irregular grazing. As a matter of fact, studies (Koç et al., 2013; Severoğlu 2018; Çelik 2019; Bilgili and Koç 2020) reported that intensive grazing in rangelands weakens the rangeland condition as the desirable plant species ratios present in the botanical composition decrease.

Table 6. Rangeland condition and health classes of rangeland sites grazed at different intensities

Rangeland condition and health class	**the lightly grazed**	**moderately grazed**	**heavily grazed**
	moderate-healthy	moderate-healthy	weak-risky

4. Conclusion

In the light of the data we obtained as a result of the study, it is noteworthy that the effect of both ecological and grazing intensities in the areas allocated between the sites is important for these differences in terms of the factors examined among the sites studied. In the study, it was recorded that the heavily grazed and sheep grazed site was in a very poor condition in terms of botanical composition and rangeland condition and health compared to the other sites. For this reason, it is very important for the sustainability of rangelands to make a good grazing planning in order to reduce the effect of grazing intensity on the rangeland site, especially in the heavily grazed site.

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