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COMPARING THE IMPACTS OF LIVESTOCK AND WILDLIFE GRAZING ON SOME SOIL NUTRIENTS IN A SEMI-ARID RANGELAND

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Abstract: Rangeland sustainability is altered by animal grazing. As one of the main ecological disturbances, grazing alters the cycle of soil nutrition contents in the soil of rangeland ecosystems. This research was carried out to compare the impact of wildlife and livestock grazing on the soil nutrient content of Lashgar Dar, which is a semi-arid rangeland (Malayer City, Hamadan Province). Based on the ANOVA results, the Cu, K, Fe contents in the two studied areas differed significantly ($P<0.01$). The Cu content significantly increased to 0.15 and 0.36 $mgkg^{-1}$, for wildlife and livestock grazing, respectively. The Fe concentrations in the soil were significantly higher in the livestock grazing area (2.58 $mgkg^{-1}$) than the wildlife grazing area (1.48 $mgkg^{-1}$). The K concentrations significantly increased in the livestock grazing area (17.51 $mgkg^{-1}$). The lowest concentration of K (9.48 $mgkg^{-1}$) was obtained in the wildlife grazed area. The results of comparing Zn, Mg, Mn contents demonstrated that there were significant ($P<0.01$) differences between the two regions in terms of Mg and Mn two studied areas in the Lashgar Dar Rangeland. The amount of Zn in the livestock-grazed area (1.24 $mgkg^{-1}$) was in general more than that of the wildlife grazed area (0.77 $mgkg^{-1}$). It can be concluded that in the studied region, which is semi-arid, due to the lack of palatable plants and the presence of a large number of non-palatable plants, the livestock and wildlife were the same in selecting the plants. Grazing by wildlife animals naturally differs from grazing by livestock. The soil temperature could increase due to vegetation removal because of grazing intensity and warmer soils commonly have lower organic matter because of faster mineralization rates.

Keywords: Grazing, Semi-arid rangeland, Livestock, Wildlife, Soil nutrient

Introduction

The grazing effect of wild animals and livestock on soil nutrient cycle is very complex. These effects are quite different based on climatic, edaphic, and topographic conditions. Iran's rangelands are usually poor in soil nutrients. Because of the special conditions of semi-arid rangelands, it is important to study the effect of domestic and wildlife animals on soil nutrients. Livestock grazing has been generally considered as a negative agent in wildlife habitats but managed grazing programs may have a positive effect on the soil and vegetation of rangelands (Vavra, 2005). Livestock grazing is usually guided by a shepherd (Ruiz-Mirazo, 2011) in contrast to wild animals freely moving on rangeland ground (Fynn, 2012). Thus, grazing by non-domestic animals naturally differs from grazing by livestock (Jackson & Bartolome, 2007).

The nutrients flux of rangelands may be different according to their climate, vegetation community composition, landscape, and grazing management practices (Bardgett & Wardle, 2003) (Reeder and Schuman, 2002). A continuous and intensive grazing can diminish the input of organic matter (Briske & Richards, 1995) which in turn reduces soil nutrients and results in soil erosion (Lavado *et al.,* 1996). Lack of organic matter can also reduce the availability of photosynthetic or meristematic tissues necessary for plant growth (Briske & Richards, 1995). However, some increases in soil nutrients are due to excreta returns (Lavado *et al.,* 1996).

As one of the main ecological disturbances (Bilotta *et al.,* 2007), grazing changes the cycle of nutrition contents in the soil (Parissi *et al.,* 2014). Grazing practices affect soil properties based on the stocking rate and grazing periods

(Sanjari *et al.,* 2008). Thirteen essential minerals for plant growth found in the soil are recognized as macro (S, K, Mg, P, Ca, and N) and micro (Zn, Fe, Mn, Cl, Cu, Mo, and B) nutrients (Epstein, 1972). Animal grazing modifies the magnitude of micro and macronutrients in the soil of rangeland ecosystems (Wu *et al.,* 2009). Livestock activities influence the nutrient cycle of soil (Mikola *et al.* 2009).

The Cu, Mg, Zn, Mn, and Fe contents in livestock grazed soil were more than those of wildlife grazed soil (Parissi *et al.,* 2014). Conversely, wildlife grazing increased the K contents of the soil compared to those of livestock grazed soil (Parissi *et al.,* 2014). In contrast to the wildlife area, the soil nutrient contents in the livestock grazed rangelands increased (Kioko *et al.,* 2012). Wildlife grazing has positive (Hossein Jafari *et al.,* 2014) or negative (Matano *et al.,* 2015) effects on soil characteristics in rangeland environments. Severe grazing leads to depletion of soil nutrients resulting in soil fertility reduction (Morgan, 1995). Moreover, livestock grazing can decrease nutrient availability in soil (Hiernaux *et al.,* 1999). In some cases, livestock can give an ecosystem unexpected benefits by increasing seed dispersal (Brown & Archer, 1988) and can enhance plant diversity (Hickman *et al.,* 2004).

Based on literature review there is not much information about the comparison of the effect of livestock and wildlife grazing on soil nutrient contents of grazed rangelands (Parissi *et al.,* 2014). The results of this research can be useful for paying more attention to grazing management in semi-arid rangelands based on the capabilities of soil and the vegetation of these areas. Therefore, the aim of the current research was to compare the effect of wildlife and livestock grazing on soil nutrient contents of Lashgar Dar, which is a semi-arid rangeland.

Materials and Method

Study Area

The current research was done in Lashgar Dar Rangeland, at 1750 to 2928 m above sea level with an average annual precipitation of 364 mm (N34°12', E48°58') (Figure 1). This area is near Malayer city, Hamedan, Iran (Akhzari *et al.,* 2015). As a semi-arid rangeland, Lashgar Dar is important for wildlife conservation and livestock grazing.

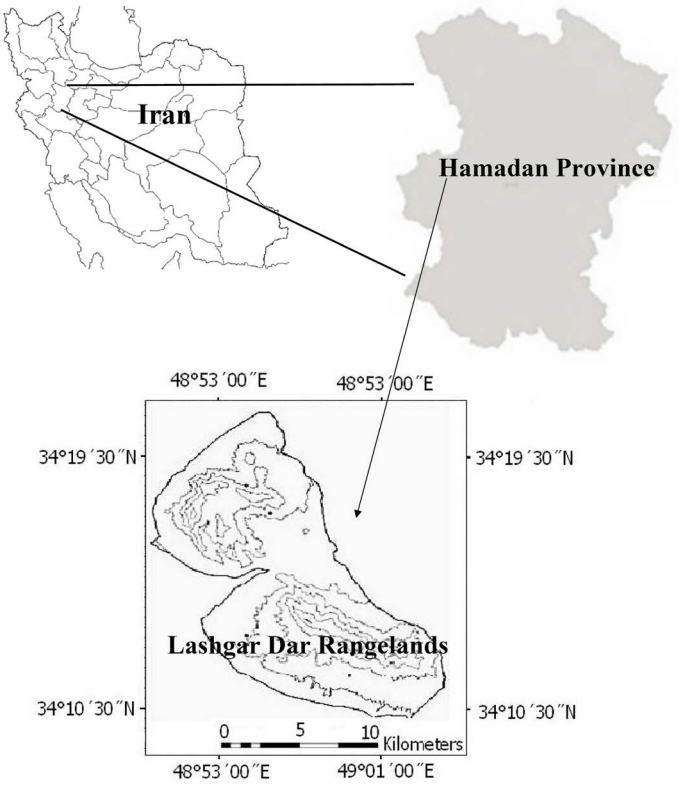

Figure 1: The location of Lashgar Dar Rangeland

Two sites were selected in Lashgar Dar Rangeland in order to compare the effects of livestock and wildlife grazing on soil characteristics. Two regions were determined for soil sampling based on topographic maps and field investigation (Hossein Jafari *et al.,* 2014). One of these regions was in the protected area and under wild goat *(Capra aegagrus)* and wild sheep *(Ovis orientalis)* grazing. The other was in outside of the protected area and was under livestock (sheep) grazing. Soil samples from the top soil (0-10 cm) were obtained by the use of a hand auger. The randomized systematic method was used for soil samplings. Five 1000 m transects were randomly located within each area (wildlife and livestock grazing areas). Soil samples were acquired systematically every 100 m along each transect. The collected soil samples were moved to laboratory conditions and were air-dried for one week. The reverse aqua regia digestion method (HNO_3-HCl (3:1) with an ultrasonification of 45 min at 60°C and a hotplate treatment for 45 min) was utilized for the digestion of soil samples. The Cu, Fe, K, Mg, Mn, and Zn contents were determined by atomic absorption spectrometry.

Statistical analysis

The impacts of livestock and wildlife grazing on the soil characteristics of Lashgar Dar rangeland were performed by an independent sample t-test using SPSS software (at $\alpha = 0.01$).

Results

Comparing the impacts of livestock and wildlife grazing on Cu, Fe, and K contents of Lashgar Dar Rangeland

Based on the ANOVA results (Figure 2), Cu, Fe, and K contents were significantly different in

the two studied areas (one of these regions was in the protected area, under wildlife grazing and the other was outside of the protected area, and was under livestock grazing).

The Cu content increased significantly to 0.15 and 0.36 mgkg-1, for wildlife and livestock grazing regions, respectively (Figure 2). The concentrations of Fe in the soil were significantly higher at the livestock grazing area (2.58 mgkg^{-1}) than the wildlife-grazing region (1.48 mgkg^{-1}) (Figure 2). Soil K concentration significantly increased in the livestock grazing area (17.51 mgkg^{-1}). Significant differences were observed in the soil K concentration of the wildlife-grazing region and the livestock grazing area. The lowest concentration of K (9.48 mgkg^{-1}) was found in the wildlife grazed area (Figure 2).

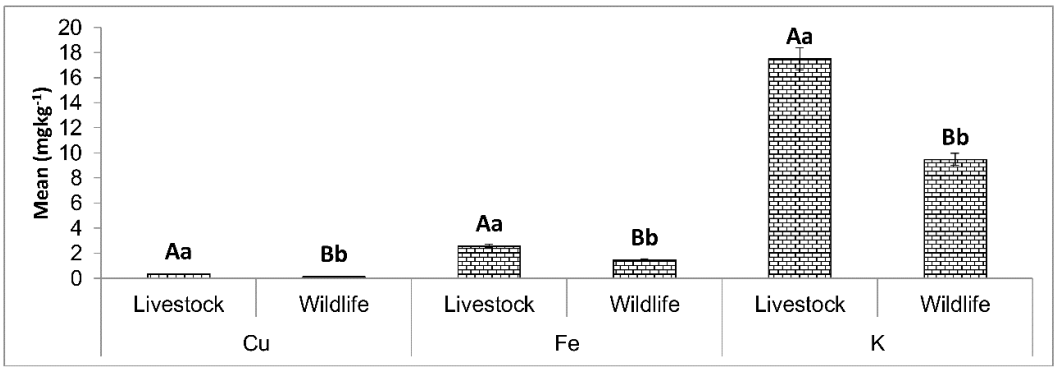

Figure 2: Comparing the Cu, Fe, and K contents in the soil of two regions under wildlife and livestock grazing using independent sample t-test

Different uppercase letters for each element show the very significant difference of (P<0.01). Different lowercase letters for each element show the significant difference of (P<0.01).

Comparing the impacts of livestock and wildlife grazing on Mg, Mn, and Zn contents in the Lashgar Dar Rangeland

The results of comparing Mg, Mn, and Zn contents demonstrated a significant difference between the two regions in terms of Mg and Mn in the two studied areas (one of these regions was in the protected area and under wildlife grazing and the other was outside of the protected area and was under livestock grazing) in the Lashgar Dar Rangeland (Figure 3). The results of comparing Mg, Mn, and Zn contents demonstrated that there was a significant (P<0.01) difference between the two regions in terms of Mg and Mn in the two studied areas in the Lashgar Dar Rangeland. The amount of Zn in the livestock grazed area (1.24 mgkg-^{1}) was in general more than that of the wildlife grazed area (0.77 mgkg-^{1}).

However, based on the ANOVA results (Figure 3), comparing the content of Zn in the two sites indicated that there were no significant differences between the two regions with regard to the Zn content of soil and. Nevertheless, the Zn content of soil in the livestock grazed area was generally more than that of the wildlife grazed area (Figure 3).

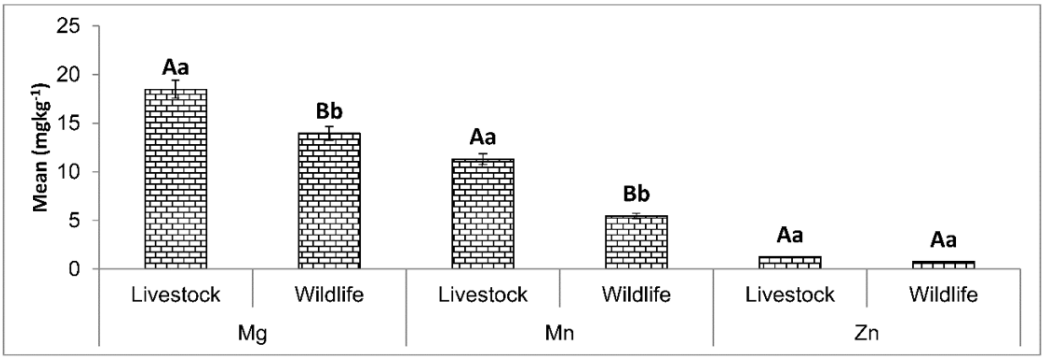

Figure 3: Comparing Mg, Mn, and Zn contents in the soil of the two regions under wildlife and livestock grazing using independent sample t-test. Different uppercase letters for each element show the very significant difference of ($P<0.01$). Different lowercase letters for each element show the significant difference of ($P<0.05$).

Discussion

Comparing the impacts of livestock and wildlife grazing on Cu, Fe, K, Mg, Mn, and Zn contents in the Lashgar Dar Rangeland

Animal grazing modifies the magnitude of nutrient in the soil of rangelands (Wu *et al.,* 2009). Based on the results of this study (Figures 2 and 3), the Cu, Fe, and K contents differed significantly in the two studied areas (one of these regions was in the protected area and under wildlife grazing and the other was outside of the protected area which was under livestock grazing). These results are consistent with the study of Bardgett & Wardle (2003) and Reeder & Schuman (2002) who considered the nutrients flux of rangelands as changeable parameters based on their climate, vegetation community composition, landscape, and grazing management practices. According to Mikola *et al.* (2009), livestock activities influence the nutrient cycle of the rangeland soil.

The results of the studies of Briske & Richards (1995) showed that continuous and intensive grazing could diminish the amount of nutrients in rangeland soils. A continuous and intensive grazing can reduce the input of organic matter (Briske & Richards, 1995) which in turn diminishes soil nutrients and causes soil erosion (Lavado *et al.,* 1996).

The results of the present study showed an increasing trend in the amounts of K, Fe, Cu, Mg, Zn, and Mn at the livestock grazed area compared to the wildlife grazing region (Figures 2 and 3). These results are inconsistent with the results of the study of Briske & Richards (1995). The increase in nutrient content of the soil may be due to the mineralization process. The soil temperature could be increased as vegetation is removed by livestock (Vermeire *et al.,* 2005). Warmer soils commonly have lower organic matter because of faster mineralization rates (Bot & Benites, 2005). The mineralization rates of livestock grazing area were higher than those of wildlife grazed region because the grazing intensity of livestock grazing region was higher than that of wildlife grazing in Lashgar Dar rangeland.

However, the findings of the present study are consistent with was those of Lavado *et al.* (1996) who reported increases in the soil nutrients of the rangeland due to the excreta returns of grazing animals. In agreement with the present study, Kioko *et al.* (2012) reported that the soil nutrient content under livestock grazing rangelands increased more than that of the wildlife area.

Conclusion

Based on literature review, there is little information about the comparison of the effect

of livestock and wildlife grazing on soil nutrient contents of rangeland regions. In general, it can be concluded that in the studied region which was semi-arid due to the lack of palatable plants and the presence of a large number of non-palatable plants, the livestock and wildlife were the same in selecting the plants. Perhaps this result can be generalized to most semi-arid rangelands of Iran due to the poor vegetation and the shortage of palatable plants.

Grazing by wildlife animals naturally differs from grazing by livestock. The grazing of livestock is carried out under the guidance of a shepherd in a certain season of the year, but the grazing of wild animals is not managed by shepherds and they are always present in the rangelands. Therefore, the aim of this research was to compare the effect of wild and domestic grazing animals on soil nutrient content in Lashgar Dar rangeland. This study indicated that the mineralization rates of livestock grazing area were higher than those of nondomestic grazed area because the grazing intensity in the livestock grazed region is higher than that of the wildlife grazed region in Lashgar Dar rangeland. The soil temperature could increase due to vegetation removal because of grazing intensity and warmer soils commonly have lower organic matter because of faster mineralization rates.

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