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The Effects of Wildlife (Deer) and Livestock (Sheep and Goat) Grazing on Species Diversity and Richness, and Plant Composition in the Steppe Rangelands of Mehriz

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Abstract

To assess the impact of grazing on the diversity, richness and evenness of vegetation, several indices and information on plant composition are necessary because of their different sensitivity to grazing gradients and kinds of herbivores. Thus, the purpose of this study was to compare these indices between two wildlife and livestock grazing sites in steppe rangelands of Mehriz. Sampling was performed using a random systematic method in April 2012 (10 transects of 100m and three plots of 2m2 were placed on each transect on each site). The species name, plant families, longevity and canopy cover percentage were determined in each plot and along each transect. Finally, the data were analysed using an independent sample t-test. The results showed that the canopy cover percentage of *Colchicum kotschyi*, *Iris songarica* ($p<0.05$) and *Stachys inflata* ($p<0.01$) significantly increased while the percentage of *Artemisia sieberi*, *Stipa barbata* ($p<0.01$) and *Scorzonera sp.* ($p<0.05$) canopy cover was revealed to have significantly decreased in deer grazing areas. The results of a statistical analysis showed that deer grazing has caused plant diversity indices to increase such as Shannon, Simpson and evenness ($p<0.01$). However, the Margalef and Menhinick indices did not show any significant difference between the two sites.

Key words: plant composition, diversity, richness, livestock, wildlife, steppe rangelands.

تاثیر چرای حیات وحش (آهو) و دام اهلی (گوسفند و بز) بر شاخص های تنوع و غنای گونه ای و ترکیب گیاهی در مراتع استپی مهریز

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چکیده

در ارزیابی اثر چرا بر پوشش گیاهی در نظر گرفتن شاخص های تنوع، غنا، یکنواختی، تعداد و ترکیب گیاهی از اهمیت ویژه ای برخوردار می باشد زیرا حساسیت آنها در پاسخ به گرادیان چرا و نوع دام چرا کننده متفاوت می باشد، لذا هدف تحقیق مقایسه شاخص های مذکور بین دو سایت چرایی حیات وحش و دام اهلی در مراتع استپی مهریز بود. نمونه برداری در دو منطقه مذکور در اردیبهشت ماه سال ۱۳۹۱، به طور تصادفی سیستماتیک انجام شد (۱۰ ترانسکت ۱۰۰ متری و ۳ پلات ۲ متر مربعی در هر منطقه). در داخل هر پلات و در امتداد هر ترانسکت، نام گونه های گیاهی، تیره های گیاهی، طول عمر و درصد پوشش به تفکیک گونه تعیین گردید. در نهایت مقایسه میان داده ها در دو منطقه با استفاده از آزمون t انجام شد. نتایج نشان داد که در سایت چرایی آهو، درصد پوشش گونه های Colchicum kotschyi، Iris songarica ($p<0.05$) و گونه Stachys inflata ($p<0.01$) افزایش معنی دار داشته و گونه های Artemisia sieberi، Stipa barbata ($p<0.01$) و گونه Scorzonera sp. ($p<0.05$) دارای کاهش معنی‌دار بوده است. همچنین نتایج آنالیز آماری شاخص های تنوع و غنا نشان داد که چرای آهو برای دو شاخص تنوع گیاهی شامل شانون-وینر و سیمپسون و همچنین شاخص یکنواختی افزایش معنی دار را به همراه داشته است ($p<0.01$) و شاخص های غنای مارگالف و منهینیک تغییر معنی داری را در این ارتباط نشان ندادند.

کلمات‌کلیدی: ترکیب گیاهی، تنوع، غنا، دام اهلی، حیات وحش، مراتع استپی.

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1- Introduction

An important goal of habitat managers is to maintain or increase the diversity of plant species in arid and semi-arid ecosystems [21]. Species diversity, as one of the main and fastest indices for determining ecosystem conditions, is largely used in vegetation studies and environmental assessments [12, 51], and consists of species richness (the number of species observed in the plots) and evenness (the distribution of species individuals) [31]. Grazing is one of the factors which effect theses parameters. Excessive grazing pressure will lead to vegetation destruction and finally soil and rangeland ecosystem degradation [4]. Wildlife and livestock grazing cause changes in vegetation and plant composition [53]. Some of these changes consist of a reduction of palatable species and an increase in thorny, poisonous and pincushion plants [3, 5, 13, 24, 25, 32]. These changes can cause a reduction in the diversity and richness of species [15, 30, 37, 52]. Salami et al. (2007), Moeinpoor (2008), Pei et al. (2008) and Jahantab et al. (2010) revealed that exclosure can cause an increase in vegetation diversity, richness and evenness. Ghahsare ardestani et al. (2010) in assessing suitable indices for investigating the diversity of species, announced that the richness parameters in semi-arid areas and the evenness parameters in the Artemisia plains showed more diversity. Gabriel (1998) and Virginie et al. (2003) have shown that moderate grazing raises species diversity and richness while heavy grazing and exclosure cause a reduction in species richness and diversity. Studies by Tilman et al. (2001) and Barker et al. (2004) had similar results. Hickman et al. (2004) studied the effects of grazing management on the richness of species in Kansas grasslands. They found that there is no significant difference between grazing systems in terms of the effects on diversity and richness but grazing intensities affect these indices so that, after increasing grazing pressure, the frequency of perennial tall grasses decrease. There was no significant difference in terms of forbs. Bilotta et al. (2007) reported a reduction in forbs canopy cover percentage in their studies. Zhaoa et al. (2007) showed that high pressure grazing decreases the diversity of valuable plants and also changes dominant species' morphologic structures. Zamora et al. (2007) announced that there is a close relationship between grazing intensity, traditional human activities, and the diversity and richness of species. Moderate human activities can maintain diversity and richness in these ecosystems. Cuevas et al. (2012) investigated wildlife grazing effects in Argentina and their results showed that wild boar decreases diversity and richness significantly.

Number indices and plant composition are important to assess the effects of grazing on the diversity, richness and evenness of vegetation because their sensitivities differ in response to grazing gradient and kind of herbivores [22]. With respect to this issue, rangeland ecosystem conservation is related to management on the basis of quantitative development and maintaining the most endemic species. Thus, the recognition, measurement and surveying of species diversity and richness are necessary. The purpose of this study is to compare these indices between two wildlife (deer) and livestock (sheep and goat) grazing sites, using the results to plan and manage rangelands in the future.

2- Materials and Methods

Study site

Mehriz is located south of Yazd province in the margins of the Yazd-Kerman road. This area of study is located at 31˚ 20' north latitude and 54˚ 30' east longitude and includes two regions under wildlife (deer) and livestock (sheep and goat) grazing. Most of this area is covered with plains and the rest is impassable heights, mountains and hills. The average altitude is 1616 meters above sea level and the average maximum and minimum heights are 1600-1800 meters. The average maximum and minimum temperatures are 44.29˚C and 22.5˚C, respectively, and the mean annual moisture is 30%. The amount of precipitation changes between 50 mm and 150 mm at different sea levels [29].

Methodology

The area of study was determined using topographic maps (1:50000). During the field investigation, two plain regions were determined, one in the protected area under wildlife grazing (deer) and the other, outside that area, under livestock grazing (sheep and goat). Their climatic and topographic conditions are the same and the only factor that causes any difference between the study sites is grazing [2, 11]. After determining the study sites, sampling was performed using a random systematic method in April 2012. Depending on the vegetation type and condition [35], 10 random transects of 100m and three plots of 2 m^2 were placed on each transect using a systematic method on each site. In each plot and along each transect, species names and families, the canopy cover and total canopy cover percentage were noted.

Some indices such as Simpson and Shannon-Wiener (diversity indices), Evenness, Margalef and Menhinick (richness indices) were used to calculate diversity and richness [10]. They have a greater ability to determine the mentioned parameters among different indices [34]. The Simpson index is influenced by the frequency of dominant species but Shannon-Wiener is affected by the richness of species [55]. Number index was also analysed as a factor that affects changes in the richness of species. All calculations were done using *Past* software [36]. Data processing and analysis related to species canopy cover percentage and different indices between the two study regions were performed using *SPSS16* software (independent sample t-test analysis).

3- Results

During sampling, 27 plant species of 10 families were found in the region under wildlife grazing; 25 species belonging to 10 families were identified in the livestock grazing site. These species have different life forms such as forb, grass and shrub (Table1).

Table1. Presence and absence of species in two wildlife and livestock grazing sites (according to sampling).

Species name	Family	Longevity	Wildlife grazing site	Livestock grazing site
Acantholimon sp.	Papaveraceae	P	+	-
Aegopordon berardioides	Compositeae	P	+	-
Aellenia subaphylla	Chenopodiaceae	P	-	+
Artemisia sieberi	Compositeae	P	+	+
Astragalus glaucacanthus	Papaveraceae	P	+	+
Astragalus microphysa	Papaveraceae	P	+	-
Astragalus sp.	Papaveraceae	P	+	+
Atraphaxis spinosa	Polygonaceae	P	-	+
Boissiera squarrosa	Gramineae	A	+	+
Centaurea sp.	Compositeae	P	+	+
Cirsium sp.	Compositeae	P	+	+
Colchicum kotschyi	Liliaceae	P	+	+
Convolvulus virgatus	Convolvulaceae	P	+	-
Cornulaca leucacantha	Chenopodiaceae	A	+	-
Cornulaca monacantha	Chenopodiaceae	P	-	+
Cousinia deserti	Compositeae	P	+	+
Cyprus sp.	Chenopodiaceae	A	-	+
Echinops sp.	Compositeae	P	-	+
Euphorbia helioscopia	Euphorbiaceae	A	-	+
Gymnocarpus decander	Lamiaceae	P	-	+
Heliotropium sp.	Boraginaceae	P	+	-
Iris songarica	Iridaceae	P	+	+
Jurinea radians	Compositeae	P	+	-
Lactuca sp.	Compositeae	P	+	+
Launea acantodes	Compositeae	P	+	+
Lolium rigidum	Gramineae	A	+	-
Noaea mucronata	Chenopodiaceae	P	+	-
Paracaryum persicum	Boraginaceae	P	+	-
Pganum harmala	Zygophyllaceae	P	-	+
Salsola tomentosa	Chenopodiaceae	P	-	+
Scariola orientalis	Compositeae	P	+	+
Scorzonera sp.	Compositeae	P	+	+
Scrophularia steriata	Scrophulariaceae	P	+	-
Stachys inflata	Lamiaceae	P	+	-
Stipa barbata	Gramineae	P	+	+
Ziziphora tenuir	Lamiaceae	A	+	+
Zygophyllum eurypterum	Zygophyllaceae	P	-	+

P: Perennial; A: Annual

According to Figure 1, the highest percentage of the composition of the species in the deer grazing site (85.19%) and the livestock grazing site (84.00%), is related to perennial species, while 14.81% (wildlife grazing site) and 16.00% (livestock grazing area) of species composition belong to annual species, respectively.

The results of comparing species with the greatest canopy cover percentage in sampling plots show that there is no difference between the two regions in terms of percentage of species canopy cover, such as *Launea acantodes*, *Cousinia deserti*, *Boissiera squarrosa*, *Astragalus sp.* and *Lactuca sp.* Species like *Colchicum kotschyi*, *Iris songarica* ($p<0.05$) and *Stachys inflata* ($p<0.01$) reveal a significant increase in the deer grazing site, but some species, such as *Artemisia sieberi*, *Stipa barbata* ($p<0.01$) and *Scorzonera sp.* ($p<0.05$) showed a significant reduction in that site compared to livestock grazing site (Table 2).

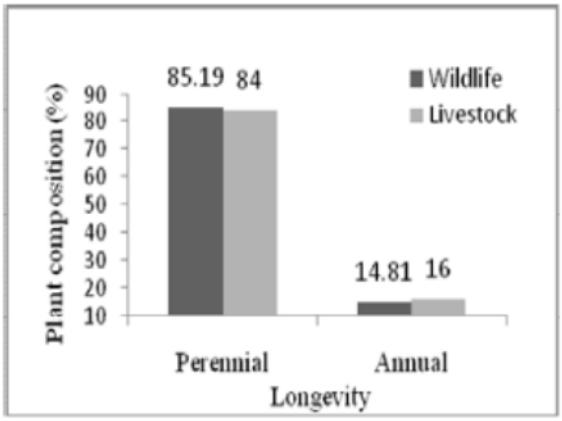

Figure 1. Species composition chart with longevity in two sites under wildlife and livestock grazing.

Table2. Comparing species with the most canopy cover percentages using independent sample t-test in two study sites.

Species	Treatment	Canopy cover percentage (average)	Sd	df	t
Launea acantodes	Wildlife	0.030	0.063	58	ns - 0.974
	Livestock	0.130	0.162		
Colchicum kotschyi	Wildlife	0.185	0.181	58	* 2.229
	Livestock	0.050	0.062		
Iris songarica	Wildlife	0.660	0.336	58	*2.300
	Livestock	0.250	0.453		
Artemisia sieberi	Wildlife	5.065	1.608	58	** - 4.729
	Livestock	7.915	1.022		
Stachys inflata	Wildlife	2.055	1.059	58	**6.135
	Livestock	0.003	0.003		
Stipa barbata	Wildlife	0.020	0.042	58	** - 4.405
	Livestock	0.185	0.111		
Cousinia deserti	Wildlife	1.795	0.678	58	ns - 0.863
	Livestock	2.040	0.588		
Boissiera squarrosa	Wildlife	0.320	0.173	58	ns - 0.961
	Livestock	0.395	0.175		
Astragalus sp.	Wildlife	0.240	0.227	58	ns 0.915
	Livestock	0.155	0.186		
Scorzonera sp.	Wildlife	0.270	0.111	58	* - 2.846
	Livestock	0.510	0.242		
Lactuca sp.	Wildlife	1.485	1.241	58	ns 0.142
	Livestock	1.420	0.740		

(ns: No significant), (**: $p<0.01$), (*: $p<0.05$)

The results indicate that, unlike the richness indices, diversity indices show a significant response to the type of grazing animal ($p<0.01$). Comparing species diversity indices show that the Shannon-Wiener index in the wildlife grazing site (1.86) has increased significantly compared to in the livestock grazing area (1.61) ($p<0.01$). The Simpson index in the deer grazing area (0.79) also had a significant increase ($p<0.01$) so that the amount of this index in the livestock grazing area is 0.72. Therefore, deer grazing has a significant increase in terms of these two indices. The Evenness index revealed a significant reduction in the livestock grazing site (0.43) in comparison to the region under wildlife grazing (0.56) ($p<0.01$). There is no significant difference between the two study regions in terms of richness indices (Margalef and Menhinick), which means that the type of grazing animal does not have any significant effect on plant species richness. There is also no significant difference between the two study sites in terms of the number index.

Discussion

The canopy cover percentage of *Colchicum kotschyi*, *Iris songarica* and *Stachys inflata* which belong to the *Liliaceae*, *Iridaceae* and *Lamiaceae* families increased significantly in the wildlife grazing site while some species such as *Artemisia sieberi* and *Scorzonera sp.* (*Compositeae*) and *Stipa barbata* (*Gramineae*) showed a significant increase in the livestock grazing site. The decreasing of the shrubs canopy cover and the increasing of the plants of the mentioned families can be related to deer food preferences compared to those of sheep and goats. Deer graze shrubs better than other life forms [41, 43]. According to studies by Bagheri et al. (2008), deer and sheep use the same life forms but their food preferences are not the same at different sites and times. Deer graze shrubs first while sheep prefer forbs and then shrubs; the results also showed that with livestock grazing, the forbs canopy cover percentage decreases and the proportion of shrubs increases. So, a reduction in this species' percentage of canopy cover is to be expected and corresponds with the results of the studies by Aghajanlou and Mousavi (2006), and Jalilvand et al. (2007). Since the dominant livestock (sheep) graze forbs more than any other life forms, this causes a reduction in the proportion of *Stachys inflata* (*Lamiaceae*) in the livestock grazing area. These results were also confirmed by Firinioglu et al. (2007), Heydarian Aghakhani et al. (2010) and Louhaichi et al. (2012). *Stipa barbata* canopy cover (*Gramineae*) increased significantly in the livestock grazing site. This can be

Table3. Comparing diversity, richness and evenness indices in two areas under wildlife and livestock grazing using an independent sample t-test.

Index	Treatment	Indices average	Sd	Df	t
Shannon (diversity)	Wildlife	1.857	0.165	58	3.718 **
	Livestock	1.612	0.127		
Simpson (diversity)	Wildlife	0.795	0.038	58	4.434 **
	Livestock	0.725	0.033		
Margalef (richness)	Wildlife	3.717	0.313	58	0.784 ns
	Livestock	3.599	0.363		
Menhinick (richness)	Wildlife	2.797	0.223	58	1.401 ns
	Livestock	2.644	0.263		
Evenness	Wildlife	0.563	0.059	58	6.279 **
	Livestock	0.431	0.030		
Number	Wildlife	11.50	1.27	58	- 0.383 ns
	Livestock	11.70	1.06		

(ns: No significant), (**: $p<0.01$)

caused by a higher resistance of the *Gramineae* species and their final bud location; because their bud is on the soil surface and grazing pressure injuries on these plants are less than other life forms. Increasing annual species and resistance to grazing in the livestock site can be due to grazing pressure in this region. More livestock padding enlarges ecological nests and as a consequence, annual plants increase in the region. Thus, annual species' canopy cover in the area with high grazing pressure (livestock grazing area) is more than in the wildlife grazing site. Studies by Fakhimi et al. (2007) and Pueyo et al. (2006) support this contention.

There is no significant difference between the two regions in terms of the total canopy cover percentage. The presence of some shrub species like *Cousinia sp.*, *Echinops sp.* and some of the *Astragalus* species (resistant to grazing) in the livestock grazing site cause the confidence level to decrease, significant to this difference and in spite of the fact that there is no significant difference between the two study sites, the conserved area plants have more canopy cover percentage [20].

The Margalef and Menhinick indices did not show any significant difference between the two sites and the study by Khani et al. (2011) confirms this; however, the wildlife and livestock grazing regimes can cause changes in diversity so that the greatest amount of diversity is observed in the deer grazing area; this can be a result of plant competition and medium grazing pressure as a factor in motivating plant growth and reproduction [21, 28, 50]. Plants' inability to grow again after high grazing pressure leads to a reduction in the diversity and evenness of species [10, 47]. On the other hand, these parameters increase under medium grazing pressure because, with the reasonable utilization of rangeland, the richness of species and life forms is also preserved. Different studies support these results [15, 30, 31]. Tessema et al. (2011) investigated grazing effects (livestock and wildlife) on vegetation structure and showed that the diversity of species in light grazing sites (i.e., wildlife grazing and alternative livestock grazing) was significantly more than in the area with high grazing pressure (livestock). So, the aim should be to utilize sites on the basis of moderate grazing and managers should change those regions (high grazing pressure) to moderate grazing conditions until desirable and palatable plants replace undesirable species. The studies by Hendricks et al. (2005), Meligo (2006) and Khademolhosseini (2011) demonstrated that the highest level of the diversity and evenness of species exists at the lowest grazing pressure which confirms this hypothesis.

The Simpson index changes from 0 to 1; this demonstrates the probability that two samples taken from a place randomly belong to one species. Thus, the closer this index is to zero, the lower the species diversity [10]. In this study, the Simpson index was 0.79 in the deer grazing site and 0.72 in the livestock grazing area, which shows modest diversity [31]. The Shannon index is sensitive to scarce species and usually changes between 1.5 and 3.5 [40]. A higher level of this index shows a constant condition in terms of diversity. When the Shannon index moves closer to zero, diversity decreases intensely and this may indicate unsuitable environmental conditions or increasing environmental stresses [26]. In this study, the Shannon index was 1.86 in the wildlife grazing site and 1.61 in the livestock grazing area which demonstrates low diversity in the study sites [31]. Fakhimi et al. (2007) announced that diversity under different grazing pressures is not only related to grazing pressure changes, but also to the plants' toleration of environmental stresses in arid regions. Fernandez-Lugo et al. (2009) investigated goat non-grazing over a four-year period and noted that goat grazing cannot change diversity and richness.

Since grazing cannot remove species completely in arid regions, the structure of the plant community is a more suitable factor for rangeland monitoring compared to diversity [13, 44]. The level of species diversity and richness is rather low in the study area because of the area's location which causes low

precipitation in a desert and arid region. Given that the most important utilization of this region is for animal grazing, there are few useful herbal species among the species composition. Thus, it is necessary to pay attention to this issue in order to prevent more destruction and improve plant composition.

4- Conclusions

Species diversity is relatively sensitive to grazing, so it is a more suitable factor for monitoring rangelands in arid ecosystems. Range managers should take notice of this index, and its fluctuations and reduction as one of the factors for assessing an ecosystem's resistance. According to these results, wildlife grazing does not cause any reduction in diversity. Thus, determining the regions with suitable potential is recommended in order to nurture wildlife. Attending to appropriate livestock distribution and the suitability of livestock numbers to range capacity can also be an effective way to prevent diversity reduction in a livestock grazing site.

References

[1] Aghajanlou F, Mousavi A, Investigating the effects of exclusion on qualitative and quantitative changes of rangelands vegetation (1985-2003). *Publication of Natural Resources College*; 2006; 4: 981-986. [In Persian]

[2] Alikhani A, Ahmadi M.R, Range Management Project of Sarve, Ernan, Kamalabad Winter Rangeland. Department of Natural Resources and Watershed, Yazd Province; 2012. p.70. [In Persian]

[3] Asadian Gh, Akbarzade M, Sadeghimanesh M.R, Investigation of vegetation changes in two grazed and enclosed sites in Gian Nahavand rangelands. *Iranian Journal of Range and Desert Research*; 2009; 16(3): 343-352. [In Persian]

[4] Azarnivand H, Zare Chahoki M.A, Rangeland inventory. Tehran: Tehran University Press; 2008. P.246. [In Persian]

[5] Badripour H, The effect of distances from trough on vegetation characteristics and condition. Range Management, MSc. Thesis, Natural Resources College, Tehran University; 1997. p.78. [In Persian]

[6] Bagheri E, Mesdaghi M, Amirkhani M, Comparison of vegetation composition under exclosure, gazelle and sheep grazing in Golestan National Park and vicinities. *Pajouhesh and Sazandegi*; 2008; 80: 83-93. [In Persian]

[7] Barker D.J, Dodd M.B, Wedderbum M.E, Plant diversity effects on herbage production and compositional changes in New Zealand hill country pastures. *Grass and Forage Science*; 2004; 59(1): 12-29.

[8] Bilotta G.S, Brazier R.E, Haygarth P.M, The impacts of grazing animals on the quality of soils, vegetation, and surface waters in intensively managed grasslands. *Advances in Agronomy*; 2007; 94: 237-250.

[9] Cuevas M.F, Mastrantonio L, Ojeda R.A, Jaksic F.M, Effect of Wild boar disturbance on vegetation and soil properties in the Monte Desert, Argentina. *Mammalian Biology*; 2012; 77: 299-306.

[10] Ejtehadi H, Sepehri A, Akkafi H, Methods of biodiversity measurement. Mashhad: Publication of University of Mashhad; 2009. p.178. [In Persian]

[11] Environment Administration of Yazd Province. Unpublished reports; 2011. [In Persian]

[12] Fahimipoor E, Zare Chahouki M.A, Jafari M, Goldansaz M, Mohhebi Z, Investigation of Plant Diversity in Middle Rangelands of Taleghan by using BIO-DAP. *Journal of Rangeland Science*; 2010; 1(1): 47-51. [In Persian]

[13] Fakhimi E, Dyanati Gh.A, Mesdaghi M, Naderi H, The effect of gradient grazing on species

diversity and plant community structure in steppic rangelands of Nodushan, Yazd Province, Iran. The Second National Conference of Iran Ecological Agriculture; 2007; 657-671. [In Persian]

[14] Fakhimi Abarghoui A, Dianati Tilki Gh, Mesdaghi M, Naderi Nasrabad H, The effect of distances from trough on vegetation diversity and composition in arid rangelands of Nodushan in Yazd province. *Rangeland Journal*; 2009; 3(1): 41-52. [In Persian]

[15] Faryabi N, Comparison of plant diversity under different utilization intensities in shrub rangelands of Khebr National Park and adjacent regions. Range Management MSc. Thesis, Natural Resources College, Agricultural Science and Natural Resources University of Gorgan; 2006. p.102. [In Persian]

[16] Fernandez-Lugo S, Nascimento L, Mellado M, Bermejo L.A, Arevalo J.R, Vegetation change and chemical soil composition after 4 years of goat grazing exclusion in a Canary Islands pasture. *Agriculture, Ecosystems and Environment*; 2009; 132: 276- 282.

[17] Firinioglu H.K, Seefeldt S.S, Sahin B, The effects of long- term grazing exclosures on range plants in the Central Anatolian region of Turkey. *Journal of Environment Management*; 2007; 39: 326- 337.

[18] Gabriel O, Andress C, Stable states in relation to grazing in Patagonia: a 10 year experimental trial, *Journal of Arid Environment; 1998;* 40: 113-131.

[19] Ghahsare Ardestani E, Basiri M, Tarkesh M, Borhani H, Suitable factors for investigation of biodiversity in four pasture regions in Isfahan Province. *Rangeland Journal*; 2010; 4(1): 33-46. [In Persian]

[20] Gharehdaghi H, Investigation of exclusion on vegetation composition in steppic rangelands of Neer, Yazd Province. Natural Resources and Environment Second Regional Conference, Islamic Azad University, Branch Arsanjan; 2008. [In Persian]

[21] Ghorbani J, Taya A, Shokri M, Naseri H.R, Comparison of Whittaker and Modified-Whittaker plots to estimate species richness in semi-arid grassland and shrubland. *Desert*; 2011; 16: 17-22. [In Persian]

[22] Hendricks H.H, Bond W.J, Midgley J.J, Novellie P.A, Plant species richness and composition a long livestock grazing intensity gradients in a Namaqualand (South Africa) protected area. *Journal of Plant Ecology*; 2005; 176: 19-33.

[23] Hickman K.R, Hartnett D.C, Cochran R.C, Owensby C.E, Grazing management effects on plant species diversity in tall grass prairie. *Journal of Range Management*; 2004; 57: 58-65.

[24] Hoshino A, Yoshihara Y, Sasaki T, Okayasu T, Jamsran U, Okuro T, Takeuchi K, Comparison of vegetation changes along grazing gradients with different numbers of livestock. *Journal of Arid Environment*; 2009; 73: 687-690.

[25] Hosseinzade G, Jalilvand H, Tamartash R, Vegetation characteristics and some soil chemical properties in rangelands with different grazing intensities. *Iranian Journal of Range and Desert Research*; 2007; 14(4): 500-512. [In Persian]

[26] Jahantab E, Sepehry A, Hanafi B, Mirdeilamy S.Z, Comparison of plant species diversity in two grazed and enclosed rangeland sites in mountainous rangelands of central Zagros (Case study: Dishmook in Kohgiluyeh and Buyer Ahmad Province). *Iranian Journal of Range and Desert Research*; 2010; 17(2): 292-300. [In Persian]

[27] Jalilvand H, Tamartash R, Heydarpour H, Grazing impact on vegetation and some soil chemical properties in Kojour rangelands,

Noushahr, Iran. *Journal of Rangeland*; 2007; 1: 53-66. [In Persian]

[28] Jouri M.H, Tamzad B, Shokri M, Banihashemi B, Comparison of diversity and richness indices for evaluation of mountain rangeland health (Case study: rangelands of Javaherdeh of Ramsar). *Rangeland Journal*; 2008; 2(4): 344-356. [In Persian]

[29] Karimian A.A, Investigation and identification of plant species in Kalmand-Bahadoran protected area. Environmental Research Project; 1999. p.98. [In Persian]

[30] Khademolhosseini Z, Comparison of numerical plant species diversity indices in three sites of different grazing intensities (Case study: Gardane Zanboori Rangeland of Arsanjan). *Rangeland Journal*; 2011; 4 (1): 104-111. [In Persian]

[31] Khani M, Ghanbarian G, Kamali Maskooni E, Comparison between plant species richness and diversity indices along different grazing gradients in southern warm-arid rangelands of Fars. *Rangeland Journal*; 2011; 5(2): 129-136. [In Persian]

[32] Kohandel A, Chaeichi M, Arzani H, Mohseni Saravi M, Zahedi Amiri Gh, The effect of livestock grazing intensities on vegetation composition and soil moisture, mechanical resistance and permeability. *Journal of Iran Natural Resources*; 2006; 59: 1001-1011. [In Persian]

[33] Louhaichi M, Ghassali F, Salkini A.K, Petersen S.L, Effect of sheep grazing on rangeland plant communities: Case study of landscape depressions within Syrian arid steppes. *Journal of Arid Environments*; 2012; 79: 101-106.

[34] Mangurran A.E, Ecological Diversity and its Measurement. Princeton: University Press, Princeton, NJ; 1988.

[35] Mesdaghi M, Range Management in Iran. Mashhad: Razavi press; 2003. p.97. [In Persian]

[36] Mesdaghi M, Plant Ecology. Mashhad: Jihad Daneshgahi Press; 2006. p.104. [In Persian]

[37] Mesdaghi M, Sadeghnejad M, Comparison of plant diversity indices of three level utilizations in semi-steppe grasslands of northeast of Iran. *Journal of Agricultural Science and Natural Resources*; 2000; 7(3): 63-76. [In Persian]

[38] Mligo C, Effect of grazing pressure on plant species composition and diversity in the semi-arid rangelands of Mobulu district, Tanzania. *Agricultural Journal*; 2006; 1(4): 277-283.

[39] Moeinpour N, Enclosure effects on vegetation in Kalpoosh rangelands. Range Management MSc. Thesis, Agricultural Science and Natural Resources University of Gorgan; 2008. p.98. [In Persian]

[40] Moghaddam M.R, Ecology of terrestrial plant. Tehran: Tehran University Press; 2006. p.84. [In Persian]

[41] Moser B.W, Witmer G.W, The effect of elk and cattle foraging on the vegetation, birds, and small mammals of the Bridge Creek Wildlife Area, Oregon. *International Biodeterioration and Biodegradation*; 2000; 45: 151- 157.

[42] Pei Sh, Fu H, Wan Ch, Changes in soil properties and vegetation following exclosure and grazing in degraded Alxa desert steppe of Inner Mongolia, China. *Agriculture Ecosystems and Environment*; 2008; 124: 33-39.

[43] Pellerin S, Huot J, Cote S.D, Long term effects of deer browsing and trampling on the vegetation of peatlands. *Biological Conservation*; 2006; 128: 316- 326.

[44] Pueyo Y, Alados C.L, Ferrer-Benimeli C, Is the analysis of plant community structure better than common species-diversity indices for assessing the effects of livestock grazing on a

Mediterranean arid ecosystem. *Journal of Arid Environments*; 2006; 64:698-712.

[45] Ruthven D.C, Grazing effect on forb diversity and abundance in a honey mesquite Parkland. *Journal of Arid Environment*; 2007; 68: 668-677.

[46] Salami A, Zare H, Amini Eshkevari T, Jafari B, Comparison of plant species diversity in the two grazed and ungrazed sites in Kohneh Lashak, Nowshahr. *Journal of Pajouhesh and Sazandegi*; 2007; 75: 37-46. [In Persian]

[47] Tahmasbi P, Rangeland Ecosystems Analysis. Pelk Press; 2009. p.350. [In Persian]

[48] Tessema Z.K, Boer W.F, Baars R.M.T, Prins H.H.T, Changes in soil nutrients, vegetation structure and herbaceous biomass in response to grazing in a semi-arid savanna of Ethiopia. *Journal of Arid Environments*; 2011; 75: 662-670.

[49] Tilman D, Reich P.B, Knops J, Wedin D, Mielk T, Lehman C, Diversity and production in a long-term grassland experiment. *Science*; 2001; 294: 843-845.

[50] Virginie B, Tessier M, Digaire F, Vivier J.P, Valery L, Gloaguen J.C, Lefeuvre J.C, Sheep grazing as management tool in Western Europen saltmarshes. *Journal of C.R.Biol.*; 2003; 1: 148-157.

[51] Wilson S.D, Tilman D, Quadratic variation in old-field species richness along gradient of disturbance and nitrogen. *Ecology*; 2002; 83: 492-504.

[52] Yayneshet T, Eik L.O, Moe S.R, The effects of exclosures in restoring degraded semi-arid vegetation in communal grazing lands in northern Ethiopia. *Journal of Arid Environments*; 2009; 73: 542-549.

[53] Yeo J.J, Effects of grazing exclusion on rangeland vegetation and soils, East Central Idaho. *Western North American Naturalist*; 2005; 65(1): 91-102.

[54] Zamora J, Verdu J.R, Galante E, Species richness in Mediterranean agroecosystems: Spatial and temporal analysis for biodiversity conservation. *Journal of Biological Conservation*; 2007; 134: 113-121.

[55] Zare Chahoki M.A, Jafari M, Azarnivand H, Relationship between species diversity and environmental factors (Case study:Artoon-Fashandak Rangelands of Taleghan). *Rangeland Journal*; 2009; 2: 171-180. [In Persian]

[56] Zhaoa W.Y, Lia J.L, Qi J.G, Changes in vegetation diversity and structure in response to heavy grazing pressure in the northern Tianshan Mountains, China. *Journal of Arid Environments*; 2007; 68: 465-479.