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Study of seasonal changes in production and consumption of range plant *Artemisia sieberi* (Dehno- Kerman Province)

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Abstract

Artemisia sieberi is one of the appropriate forage plants to provide forage for livestock and it is suitable for soil conservation purposes in the steppe rangelands such as rangelands in Dehno (Kerman, Iran). Production and consumption of forage of *Artemisia sieberi* were carried out for four years. For this purpose, the residual forage after grazing was taken at intervals of one month. The consumption was determined by the subtraction of the residual forage from the production within the enclosed area. Finally, the impact of the years of study and months of grazing on the production and consumption of species in the region was analyzed using SAS software. The results showed that the year (2007) and the year (2008) has the highest and the lowest production, respectively, so that the average of 41.5% pasture forage was produced by species of *Artemisia sieberi* in the four years. On average, 30% of the production was used by livestock during the grazing season. The Years 2007 and 2008 have the highest and the lowest forage consumption, respectively. The highest production of *Artemisia sieberi* was in late September. Consumption of this species by livestock during the months of April and May is low because of high essence of this plant and the presence of the other desirable species. The area is grazing heavily by livestock in September. With regard to the consumption of this species by livestock and high production of *Artemisia sieberi*, it is a good source of forage in steppe rangeland. (248 words)

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Introduction

Rangeland ecosystems are the most extensive areas of the country. For proper management of this ecosystem, the adequate knowledge of the components and their properties is necessary. Annual, biennial and perennial Plants with different vegetative characteristics and different phenology constitute the plant composition of the majority of the rangelands. So each and every species of vegetative forms and each related species during a particular grazing period are active and have a given production, which the investigation of the production and consumption of these plants and proper management of them is necessary for good planning and management of livestock and rangeland. Sharifi Yazdi *et al.* (2013) in a study on the impacts of forage consumption on its production and the vitality of *Artemisia sieberi* have resulted that the impacts of the year of consumption, different intensity level of consumption and their the mutual impacts is significant in the level of 1% and its consumption in the study area is recommended about 50%. Ghasemi Aryan *et al.* (2013) have estimated the production of *Artemisia sieberi* by measuring the dimensions of the plant and they have found that there is a significant linear correlation between the production as a dependent variable with volume and the canopy and plant height as a constant variable at the level of one percent. Sharifi jolodar and Hosseini (2012) carried out a study to evaluate the effect of precipitation on *Artemisia aucheri* and they observed that there is a significant relationship between the annual production of *Artemisia aucheri* and the amount of rainfall in April and May. Sharifi and Akbarzade (2012) in the study of seasonal changes in forage production and consumption of *Artemisia fragrans* found that there is a significant difference between the forage productions of *Artemisia fragrans* in different years.

Arzani (1994) has investigated the changes in the quantity, quality and palatability of the forage in five vegetation types, and concluded that the quality and quantity of plant production in different years and in different periods of a grazing season is different and therefore the pasture capacity should be determined on the basis of the production quantity and quality of the grazing season. The purpose of this study is to evaluate the production and consumption of *Artemisia sieberi* in the arid rangelands of the Kerman province. *Artemisia sieberi* is known as the main and most abundant plant in the rangelands and it can be seen as a pure or a dominant species composition of plant types. Because of its distinctive features, it is extremely resistant against harsh environmental conditions and as a result, it is very effective in the stability and survival of vegetation of pastures in such areas (Moghimi, 2005). Artemisia bushes start to grow and to flowering in early spring and in early autumn, respectively, and seed production would be started in late autumn. With the onset of autumn rains, essence in the leaves and the branches of Artemisia will be decreased and it would be palatable for livestock. Therefore the lands are often used in fall and winter (Aryavand, 1989). In addition to the relative palatability, it is very important in terms of soil conservation. The aim of this study is evaluation of changes in forage production and consumption in the different months and years. Thus, the possibility of revising the management plan of the pasture grazing in the areas with similar vegetation types is provided and finally, it offers useful information about the dynamic production of rangeland and livestock.

Materials and methods

Study area description

The studied steppe rangeland (Dehno rangeland) is located between longitudes 56º 16' to 56º 23' East and latitudes 29º 55' to 29º 64 ' north and it is 20 kilometers away from west of Bardsir, Kerman province. The mean elevation of the area is 1850 meter above sea level. According to the synoptic station of Dastjerd, the average annual rainfall is 162 mm (table 1) and the average temperature is 13 º c. According to the modified Domarten method, the climate of the area has been determined as a dry cold desert. Also, based on the Embrothermic curve in a

long period of time, the duration of the wet season and dry season was 5 months and 7 months, respectively. Seasonal distribution of rainfall is so that 17.8% of rainfall occurs in the spring, 3% in summer, 20.5% in the fall and 58.5% in winter. Based on the long-term statistical data on the distributions of rainfall, the growing season is so that the most rainfall occurs during the winter. The soil in this area is inceptisol with a sandy loam to loam soil texture. The soil pH ranges between 6.7 to 8.2 and EC is less than 4 mmhos/ds. The exploitation system of rangelands is nomadic.

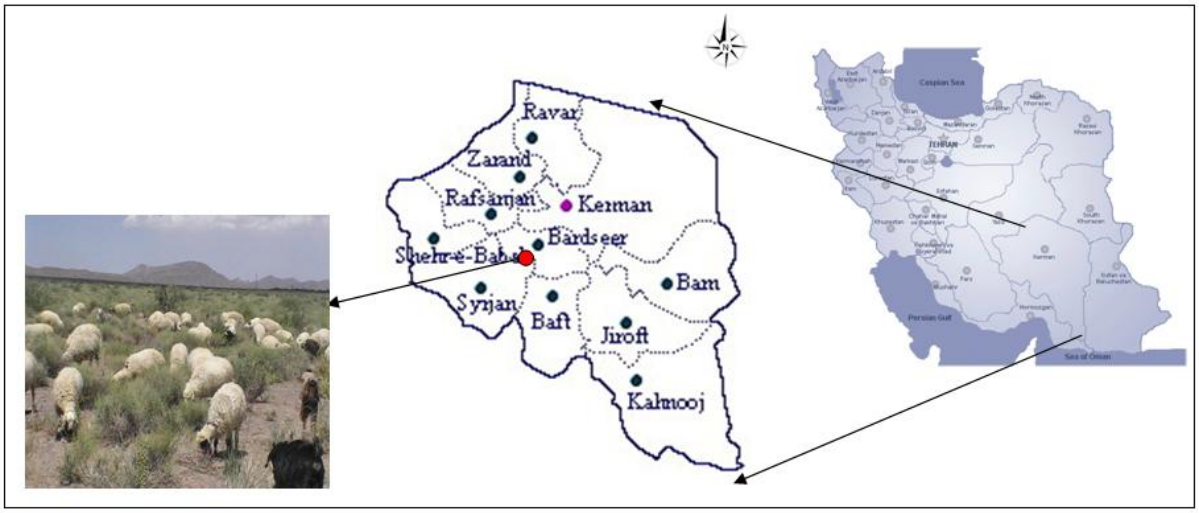

Fig. 1. Location of study area in Iran.

Artemisia sieberi – Zygophyllum eurypterum were dominant plant species. The main species are *Astragalus Spachianus, Dendrostellera lessertii, Scariola orientalis, Poa sinaica, Cousinia piptocephala, Euphorbia densa, Stipa barbata, Hertia intermedia, Noaea mucronata, Nepeta sp., Taeniaerum crinitum, Heteranthelium piliferum, Bromus tectorum, Boissiera squarrosa, Bromus Danthoniae, Tragopogon sp., Echinops sp.*

Methods

In this study, at first, an area of rangeland (one hectare) was enclosed. Then, the production and consumption of *A. sieberi* species were studied in the area. Production in the enclosed area and consumption in the outside of the area which was under grazing were measured. Production and consumption is measured in the growing and grazing season, respectively. Annual production measured in the enclosed area is started from the beginning of the growing season and continued at intervals of one month to the drying plant. The consumption was also measured on the outside of the enclosed area. For this purpose, at the beginning of the grazing season and the arrival of livestock to rangeland, the amount of residual forage of the studied species from grazing until departure of livestock from the rangeland was measured at intervals of one month, and the difference between these amounts and the production of the enclosed area, the amount of consumption was determined.

In the sampling for measuring production and consumption, plants with the average height were used. In each month, at least five plants with the average height in the enclosed area and five plants with the average height out of the enclosed area was selected and marked, then in the given time all production of them was measured. To determine the average height of the plant, in a severe systematic random sampling, the canopy cover and density of the plant was estimated in the enclosed area. Then the average canopy cover was determined by dividing the total canopy cover to the density. After cutting out the plants and drying it in the shade, the dry weight of forage production was measured and by multiplying

the production of each plant per density per hectare, the monthly production per hectare is calculated. Summation of the monthly production per hectare during the growing season produces the total production of a species in terms of a kilogram of dry matter per hectare.

Statistical analysis

The forage (production and consumption) in the statistical design of split plot in a completely randomized design with five replications for three years was analyzed in the SAS software (ver. 9.1) and the average of the studied characteristics was compared using Duncan test.

Results

According to Duncan's test (Table 2), different production of *A. sieberi* species during the studied years were statistically significant. However, this species in the year 2007 (with 200 mm rainfall) has the highest and in the year 2008 (with 31 mm rainfall) had the lowest production, which in the year 2007 compared to the year 2008; the production was increased approximately 1.2-fold. But, consumption in the year 2007 was the highest and in the years 2008, 2009 and 2010 was the lowest, respectively and it was a function of produced forage. Comparison of the studied years showed that drought in the year 2007 has resulted in significant reduction of the amount of produced forage (Fig. 1).

Table 1. Monthly and annual rainfall in Dastjerd station (2006-2010).

Month	2007 – 2006	2008 - 2007	2009 – 2008	2010 – 2009	average
September	0	0	0	0	2.1
October	9	0	12	0	5.4
November	34.5	0	33	26	25.6
December	14	33	9	5	27.8
January	90	0	9	0	36.1
February	9	10	35	0	30.9
March	22	0	0	0	20.1
April	4	0	0	0	6.5
May	0	0	0	0	2.1
June	13	0	0	0	2
July	5	0	6	0	1.6
August	0	0	0	0	1.4
annual	200.5	43	98	31	161.6

According to the Duncan's test (Table 3) the difference between production and consumption of *A. sieberi* during the months of the growing season was significant. In September, the average yield was higher than the other months and gradually with the plant growth, the production increases monthly. As in the third month the production has been increased and this has been seen in all the years and then the months, April, May, June, July, and finally August had the lowest production. The average consumption was highest in the September and there was a significant difference between September and other months. The lowest consumption is in April (Fig. 2). On average, the larger share of forage species was produced in July (30.2%) and in the months of April, May, June, July and September the share of forage production was 23, 6.5, 14.1, 7.6 and 18.4 percent (Table 4). On average, the total consumed forage by

livestock was 6.3, 7.5, 10, 13.9, 24.9 and 37.3 percent during the months of April, May, June, July, August and September, respectively (Table 4). However, the monthly consumption in different years is changing, but the significant point in the consumption is in the months of April and May which the plant has been less used by livestock, perhaps because of the presence of other desirable species.

Table 2. Comparison of the means of production and consumption of *Artemisia sieberi* in the studied years using Duncan's test (Kg / ha).

Year	production	consumption
2007	162 a	55.2 a
2008	73.7 c	22.3 b
2009	160.2 a	31.7 b
2010	139 b	26.4 b

The means of treatments with same letters were not significantly different.

Table 3. Comparison of the means of production and consumption of *Artemisia sieberi* in the studied months using Duncan's test (Kg / ha).

Month	production	consumption
April	90.5 d	11.6 c
May	23.3 e	14.5 c
June	146.6 c	20.8 bc
July	151.1 bc	31.1 bc
August	176.7 b	47 b
September	216.3 a	78.4 a

The means of treatments with same letters were not significantly different.

Discussion

According to the results the amount of *A. sieberi* production was different in the months and years of study. This could be due to various factors such as temperature and rainfall. So that in different years, the most amount of production has been reached in September. *Artemisia sieberi* is known as the main and most abundant vegetation type in steppe rangeland. This species due to its distinctive characteristics is extremely resistant against environmental conditions and consequently it is very effective in the stability and survival of vegetation in pastures. Production of this species as a critical plant of the rangeland is important and it is about 41.5 percent of the total production of the studied area. The rainfall distribution in the growing season is effective in the amount of production. In this regard, Sharifi Jolodar and Hosseini (2012) in the investigation of the effect of precipitation on the production of *Artemisia aucheri* observed that the annual production of *Artemisia aucheri* positively correlated with the amount of rainfall in April and May. However, since rainfall in 2008 was low compared to other years, so the amount of production in 2008 has a lower rate than other years. It corresponds with the results obtained by Ehsani *et al.* (2007), they have studied the effect of climate on the steppe rangeland forage production in the Markazi province and found that rainfall is the most effective indicator of climate which has an impact on the production of shrubs. Wesche (2005) also suggests that changes in vegetation cover in the arid regions are dependent on rainfall. Grazing of grasses will reduce their cover, thereby the necessary conditions for grazing of livestock of *Artemisia sieberi* are provided. The study showed that livestock consume about 30 percent of the species. Since grass varieties are on pasture in the spring and summer so livestock consume them. In the late summer, autumn and winter, due to the winter rainfall that results in vitality of the plant and also reduces the amount of essence it is well grazed by livestock. This result is consistent with the results obtained by Laycock (1967) which says that severe grazing of livestock in the spring will increase *Artemisia sieberi* and decrease the other plants. Baghestani *et al.* (2004) in their study on the production of pasture and goat grazing behavior on *Artemisia sieberi* grassland steppe region of Nodoushan Yazd in the early grazing season (spring and summer) stated that livestock feed mostly on annual and perennial species of grasses rather than perennial shrubs but late in the season, perennial shrubs are grazed more. Such terms and conditions results in the wrong exploitation of this species, though its high resistance to the grazing and

considerable growth rate in the most difficult conditions are the main characteristics of its survival and stability. But the rapid reconstruction using the simplest methods of breeding and management also contributes to the stability characteristics of this plant. Thus, the scientific management can be applied on *Artemisia sieberi* to strengthen the grazing and to revive its vegetation cover in the grazing habitats.

Table 4. The monthly relative production and consumption of *Artemisia sieberi* in different months and the share of each species in the total pasture production.

year	Relative production (%)						Relative consumption (%)						Relative production in pasture (%)	Relative consumption in pasture (%)
	April	May	June	July	August	September	April	May	June	July	August	September		
2007	29.92	11	19.29	25.20	0.79	13.78	3.77	10.79	13.91	1.99	16.56	52.98	37.4	30
2008	22.56	9	16.32	16.99	4	31	2.53	7.22	18.1	15.1	25.32	31.65	45.6	36.4
2009	18	2.47	11.66	48	9.43	10.35	7	3.54	5	27.7	29.2	27.43	40.2	24.2
2010	21.62	3.47	9.27	30.8	16.2	18.53	11.7	8.51	3.19	10.64	28.72	37.23	42.53	25.4
average	23	6.5	14.1	30.2	7.6	18.4	6.3	7.5	10	13.9	24.9	37.3	41.4	29

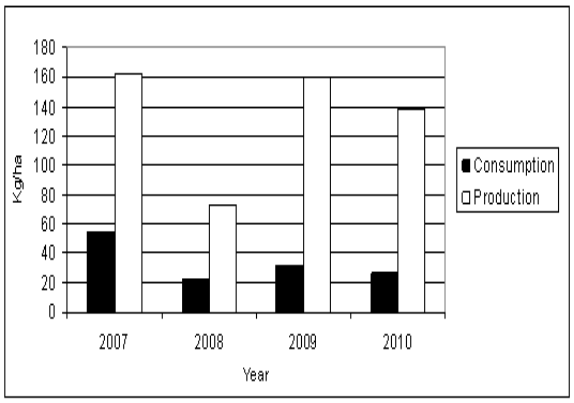

Fig. 2. Production and consumption of *A. sieberi* during years (Kg/ha).

At the time of vegetative growth, when the plant is green, and in wet years, the grazing is less, but in the years that precipitation during the growing season is low, the production of species that is more dependent on growing season precipitation (especially annual species) is low so *Artemisia sieberi* is grazed more.

At this time excessive grazing would result in damages to *Artemisia sieberi*. Researches indicate that allowable use of Artemisia is no more than 50% (Sharifi Yazdi *et al*., 2013) so if a large percentage of the species is grazed in droughts and in the growing season, it will result in damage to this valuable plant in the long-term period. In the grasslands with the high intensity of grazing which surrounding the studied area, there is a few of this plant.

Conclusion

As we know, one of the basic problems of rangelands is lack of proper management of grazing systems, which will eventually lead to the incorrect exploitation of natural forage and overgrazing. For this reason, the identification of important rangeland species in different months of the growing season can help to the proper and timely consumption of pasture forage, so that the maximum economic use of livestock products without any harm to vegetation cover, soil and the environment is possible.

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