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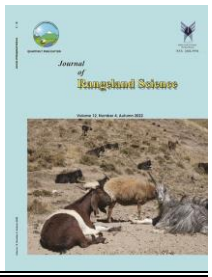

Research and Short Length Article:

Investigation of Forage Quality in Preferred Species by Camels in Aran and Bidgol Desert Rangelands, Kashan, Iran

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Received on: 17/05/2021
Accepted on: 17/10/2021
DOI: 10.30495/RS.2022.685798

Abstract. Camel's grazing in dry areas is of great importance so that in accordance with the nutritional value of the available forage for the livestock, damage to rangelands could be prevented. The objective of this study was to identify and to determine the quality of the most preferred forage species using camels in Aran and Bidgol desert rangelands, Iran. Grazing behavior of camels and their calves were observed during dry and wet seasons for a period of 84 days (August to November, 2020). The forage species were ranked based on the camels bite count. The most browsed forage was identified through observation, then they were sampled for identification of the local and scientific names. The forage quality parameters such as Crude Protein (CP), Ether Extract (EE), Calcium (Ca), Phosphorus (P), Neutral Detergent Fibre (NDF), Acid Detergent Fibre (ADF), Acid Detergent Lignin (ADL) and Dry matter digestibility (DMD) were determined in the laboratory. The most browsed forage species involving *Smirnovia iranica, Astragalus squarrosus, Nitraria schoberi, Haloxylon persicum, Seidlitzia rosmarinus* in the wet season and *Stipa barbata, Artemisia sieberi, Zygophyllum eichwaldii, Stipagrostis plumosa, Alhaji persarum* were observed in the dry season. For CP, the highest values of 25.7 and 17.9% were obtained in *Stipagrostis plumose and Astragalus squarrosus*, respectively, and for DMD%, the highest values of 72.0, 81.6 and 76.6 were obtained in *Artemisia sieberi* (leaves), *Stipa plumose* and *Haloxylon persicum*, respectively. The results of this study showed that forage quality in the wet season was much higher than dry season and camels fed on different types of forage species; the forage nutritive values could affect their selection.

Key words: Nutrition Value, Digestibility, Desert, Shrub

Introduction

Different plant species have different nutritional values, so the determination of the grazing capacity based on 1.5 or 2 kg of dry forage in all vegetation types and habitats doesn't seem logical; therefore, the necessity of determining the nutritional requirements of a livestock unit based on the indicator in all habitats and conditions is applicable (Dongmei *et al*., 2005).

Camels under pastoral systems have mixed feeding behavior where they are both grazers and browsers of a broad spectrum of forages. Their diets are varied (Dereje and Uden, 2005) and include halophytic (salty), bitter and hard-thorny herbs, shrubs, grasses, and trees that grow naturally in arid and semi-arid lands. Forage quality affects the feeding activity patterns of camels (Kassilly, 2002). Camels feeding on natural forages consume enough minerals and vitamins. However, seasonal variations in mineral status and individual mineral concentrations in forage species are limited (Onjoro *et al.*, 2006). According to Temesgen & Mohammed (2012), camels prefer browsing on forages that are high in calcium although they may be poor in phosphorus. Camels prefer holophytic forages that have high ash concentration (16-20%) (Medila *et al.*, 2015). Camels forage preference varies with season and forage nutritive value.

The purpose of this study was to determine the chemical composition and nutritional value of some range species based on camel preference for feeding.

Materials and Methods

Study area

The study site was at Maranjab Aran and Bidgol, Kshan, Iran. The area is semi-arid and is deemed too dry for cultivation. It comprises relatively intact and natural habitat, which is mainly a wildlife habitat (Batooli, 2011). It is at an altitude ranging from 890 to 912m above sea level, and geographical coordinates 34° 14' 20"N and 59°29'45"E, with an annual average rainfall of 110 mm. The climate type of the study area by modifying Domarten method is dry and soil area has been already-soil with low groundwater level. The site was selected due to the existence of a camel farmer group with a herd of more than 300 camels.

Methodology

For identification of preferred forage species, eight lactating camels were selected from different herds through visual assessment for healthy camels. The camel owners provided camels of parity, one to three and in early stage of lactation with a healthy calf. The experimental camels were ear-tagged. The lactating camels with their calves were observed for forage identification during the wet and dry seasons for 84 days during the months of August to November. The visual observations in the range were conducted between 10.00 and 18.00h. Each camel was observed while grazing in the communal land for 60 minutes daily for 5 days a week by one researcher. The end of a bite was marked by the time the camel raised its head for chewing. The number of bites made by the camel on various forage species were counted and recorded. Bites made on any particular forage species by different camels were summed up to get the total. The forage species were ranked based on the highest percentage of total bite counts throughout the study. The most preferred forages were ranked for both wet and dry seasons, local names of plants identified, and sampled for laboratory analysis. Sampling involved picking parts of the forage species consumed by the camels during the field observation.

In this research, the DM% (Dry Matter), CP(Crude Protein), EE (Ether Extract),

Ca(Calcium), P(Phosphorus), NDF(Neutral Detergent Fibre), ADF(Acid Detergent Fibre) ADL(Acid Detergent Lignin), DMD (*In vitro* Dry Matter Digestibility), total ash, Calcium (Ca) and Phosphorous (P) of *Smirnovia iranica, Astragalus squarrosus, Nitraria schoberi, Haloxylon persicum, Seidlitzia rosmarinus* in the wet season and *Stipa barbata, Artemisia sieberi, Zygophyllum eichwaldii, Stipagrostis plumosa, Alhaji persarum* in the dry season have been measured.

For quality analysis, the aerial parts of plant species were collected in 2019. The dried samples were ground by the mill, then the most forage quality indicators including energy from the calorimeter bomb device, CP with Kjeldahl method, Crude Fiber (CF) and ADF by Fiber Tec device were measured. DMD was calculated by the equation 1.

%DMD=83.58 - 0.824% ADF+ 2.628% N (Dereje and Uden, 2005)

After sample collection, they were oven-dried at 60°C for 72 hours, weighed and ground using a mill of 1-mm sieve. The proximate composition was determined using the standard procedures (AOAC, 1998). Samples were assayed for Ca through the atomic absorption spectrophotometric method. P was analyzed through calorimetric methods (Kitson and Mellon, 1944). The fiber fractions were determined according to Fiber Tec (Van Soest *et al.*, 1991).

The collected data were entered in Excel spreadsheet. Frequencies and percentages for bite counts were then computed using the SPSS software and the means of the mentioned indicators were compared**.**

Results

a) Most preferred forage species

The most preferred forage species by camels in the study area are presented in Table 1. During the wet season, the preferred species included *Smirnovia iranica, Astragalus squarrosus, Nitraria schoberi, Haloxylon persicum, and Seidlitzia rosmarinus*. During the dry season, the most preferred species were *Stipa barbata, Artemisia sieberi, Zygophyllum eichwaldii, Stipagrostis plumosa, Alhaji persarum*.

Table1. Most preferred forage species by lactating in Aran and Bidgol desert rangelands

Season	Botanical name	Local name	Category	Bite counts	% of total
Dry	*Stipa barbata*	Yal Asbi	Grass	149	22.9
	Artemisia sieberi	Terkh	Shrub	101	15.5
	Zygophyllum eichwaldii	Ghij	Shrub	76	11.7
	Stipagrostis plumosa	Sabad	Grass	208	32.0
	Alhaji persarum	KharShotor	Shrub	116	17.8
Total				650	100
Wet	*Smirnovia iranica*	Domgavi	Shrub	198	22.6
	Astragalus squarrosus	Gavan	Shrub	414	47.3
	Nitraria schoberi	GhareDagh	Shrub	63	7.2
	Haloxylon persicum	Tagh	Tree	97	11.1
	Seidlitzia rosmarinus	Eshno	Shrub	104	11.9
Total				876	100

b) Quality of forage species

The forage quality of the most preferred forage species grazed by lactating camels is presented in Table 2. The CP concentration of the forages ranged between 7.1 to 25.7%. The highest values of CP given as 25.7 and 17.9% were obtained in *Stipagrostis plumose and Astragalus squarrosus*, respectively, and the lowest value was given as 7.1% for *Artemisia sieberi* pods.

For DMD, the higher values of 72.0, 81.6 and 76.6% were obtained in *Artemisia sieberi* (leaves), *Stipagrostis plumosa* and *Haloxylon persicum*, respectively, and the lowest value as 43.4% was obtained in *Alhaji persarum*. For ADF, the higher and lower values (7.8 and 15.2%) were obtained in *Alhaji persarum* and *Astragalus squarrosus*, respectively. For Ca, the higher and lower values (3.4 and 0.7%) were obtained in *Stipa barbata* and *Artemisia sieberi* pods, respectively.

Table 2. Chemical composition (% DM) of the most preferred forage species feeding by lactating camels

Species Name	Seasons	CP	Ash	EE	Ca	P	DMD	ADF	NDF	ADL
Stipa barbata	Dry	7.4±0.8	19.3±1.2	0.9±0.2	3.4±0.0	0.2±0.0	48.5±1.3	46.3±2.9	58.6±2.1	20.1±0.7
Artemisia sieberi (leaf)	Dry	12.5±2.2	16.3±0.5	2.1±0.1	1.4±0.0	0.1±0.0	72.0±1.4	24.4±0.7	36.0±3.5	13.9±1.6
Artemisia sieberi (pods)	Dry	7.1±0.4	5.9±0.1	3.3±0.8	0.7±0.0	0.3±0.0	48.6±3.3	40.5±2.3	65.0±4.4	11.5±0.3
Zygophyllum eichwaldii	Dry	10.4±0.8	11.8±2.2	2.5±0.7	0.9±0.0	0.3±0.0	48.5±0.8	38.5±5.0	74.0±7.0	13.4±1.4
Stipagrostis plumosa	Dry	25.7±1.2	22.9±0.5	2.2±0.2	2.0±0.0	0.3±0.0	81.6±0.3	15.7±0.9	34.2±2.1	7.0 ±1.5
Alhaji persarum	Dry	8.2±0.4	9.3±1.0	1.5±0.2	1.3±0.0	0.2±0.0	43.4±0.2	47.8±2.8	73.6±1.9	18.5±2.0
Astragalus squarrosus	wet	17.9±1.3	8.2±0.1	2.0±0.1	1.7±0.1	0.3±0.0	64.2±1.3	15.2±0.9	29.1±2.7	6.6±0.4
Haloxylon persicum	Wet	7.6±0.4	6.6±0.2	1.5±0.9	1.6±0.3	0.2±0.0	76.6±0.8	28.3±0.4	32.4±1.3	19.5±0.4

CP-Crude protein, EE- Ether Extract, Ca-Calcium, P-Phosphorus, NDF-Neutral detergent fibre, ADF-Acid detergent fibre, ADL-Acid detergent lignin, DMD- dry matter digestibility

Discussion

The camels in this study were able to spread over a large area and encountered a wide variety of forage species. Shrubs constituted 60%, the most preferred forage species. These observations are in agreement with Larbi *et al.* (2011) and Abukashawa *et al.* (2016) who stated that camels tend to browse on shrubs more than grasses. Moreover, Hyder and Sneva (2003) reported that camels were mainly browsers and spent over 80% of their feeding time feeding on dicotyledons. Grass species *Stipagrostis plumosa* made a small portion of the preferred forages, which was attributed to higher abundance of other forage species and shrubs, rather than grasses. Alkali *et al.* (2017) reported that camels browse on green

tips of trees in the dry season. The *Haloxylon persicum* was highly ranked among the most preferred forage species in the wet season, but the percentage of its bite counts declined during the dry season. The camels could select the tender twigs from the thorny and small branches of *Haloxylon persicum* in the wet season as well as nibble leaves and pods of *Smirnovia iranica* in the dry season as it has thick lips and a cleft on the upper lip. It could browse on trees up to 3m height because of its long legs and neck. Their specific forage preference and feeding at higher levels above the ground minimized the direct competition with cattle, sheep, and goats. Trees and shrubs dominated in the camel diet during the wet season, but declined during the dry season when most of the species shed off their leaves. The *Acacia* spp., *Balanites aegyptiaca*, *Lycium europaeum*, and *Barleria* spp. were also observed to be among the most preferred forage species by Kassilly (2002) in North Eastern Kenya.

The CP concentration of the forages observed in this study was greater than the values reported by Kuria *et al.* (2012) who reported the ranges of 3.7 to 13.2% for the most preferred forage species by camels in Upper Eastern Kenya and North Eastern Kenya, respectively. The ash concentration ranged from 5.9 to 22.9%, the greater being for *Stipagrostis plumosa* and the lesser for *Artemisia sieberi* pods. The observations made in this study were similar to the values reported by Lakhdari *et al.* (2015) who determined 15 to 27% ash for forage species preferred by dromedaries in arid rangelands of Algeria. The similarity could be that Camels prefer halophytic forages that have high ash concentration (Medila *et al.*, 2015). Ether extract concentrations ranged from 0.9 to 3.3%, the greater being for *Artemisia sieberi* pods and the lesser for *Stipa barbata*. *Stipagrostis plumosa* and *Stipa barbata* had high calcium concentration (2.0% and 3.34%), respectively. However, they had low phosphorus concentrations (0.3% and 0.2%), respectively. In agreement, camels prefer browsing on forages that are high in calcium even where such forages are poor in phosphorus (Medila *et al.*, 2015). Moreover, camels prefer forages with high mineral content (Towhidi, 2007).

The *Astragalus squarrosus* fibre fractions were relatively low with the values of of NDF (29.1%) and ADF (15.2%) within the range of 20 to 35% NDF and 12 to 25% ADF, respectively (Hyder and Sneva, 2003). Similarly, Abdulrazak *et al*. (2000) reported 23% NDF and 16.8% ADF values for *Astragalus squarrosus* in Maranjab County in Iran. *Astragalus squarrosus* in Semnan County was reported to contain NDF (27%) and ADF (15.5%), respectively (Bagheri rad et *al*., 2009). These plants had low fibre concentrations and high DMD making them more palatable. The DMD was 64.2% in *Astragalus squarrosus*, 81.6% in *Stipagrostis plumosa*, 76.9% in *Haloxylon persicum*, and 72% in *Artemisia sieberi*. Low NDF concentration is a characteristic of good forage quality and high DMD (Jong and Yvonne, 2014), with expected positive effect on camel performance (Osuga *et al.*, 2008). However, the NDF concentrations of *Stipa barbata* (58.6%), *Alhaji persarum* (73.6%), *Artemisia sieberi* pods (65%), and *Zygophyllum eichwaldii* (74%) were above 35-40%, which is the range described as normal for forage species found in semiarid rangelands by Oddy *et al*. (1993). The NDF likely reflected in the relatively low DMD was observed for *Stipa barbata* (48.5%), *Alhaji persarum* (43.4%), *Artemisia sieberi* pods (48.6%), and *Zygophyllum eichwaldii* (48.5%). However, no obvious signs of poor performance in camels were noted. It could be due to the high capacity of camels to utilize fibrous feed material by retaining it in the rumen for a longer period to allow digestion. Moreover, camels can efficiently

digest low-quality roughages because of the wide range of ruminal microflora, which can adapt to a range of forages, active rumination, and high levels of urea recycling (Fattah *et al.*, 1999). Camels can survive on low-quality fibrous roughages compared to other livestock species as they can extract more energy from the feed they consume enabling them to survive droughts. Normally, the CP declines with the age of forages whereas the fiber fraction increases as reflected by the high NDF concentration (Shamat *et al.*, 2010). The greater the NDF of forages, the lesser the neutral detergent soluble, which includes sugars, starch, fats and CP (Oddy *et al*., 1993). There were no consistent patterns between fiber fractions and DMD on forage preference by the camels.

Conclusion

The results of this study showed that camels exhibit a mixed feeding behavior with the most preferred forage species comprising of trees, shrubs, and grasses. However, trees and shrubs with high CP and low NDF concentrations are more preferred, indicating that forage nutritive value affected the forage preference by the camels. To overcome the challenge of inadequate feed resources, there is need to strengthen the knowledge of camel keepers on the preferred forage species during the wet and dry seasons. This information can be used to optimize grazing management and supplementation to lactating camels, particularly during dry seasons.

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بررسی کیفیت گونه‌های علوفه‌ای ترجیحی توسط شتر در مراتع بیابانی شهرستان آران و بیدگل

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چکیده. این مطالعه به منظور تعیین کیفیت علوفه‌های انتخابی توسط شتر در مراتع بیابان آران و بیدگل، ایران انجام شد. رفتار چرای شترها و گوساله‌های آنها در فصول خشک و مرطوب به مدت ۸۴ روز (در سال ۱۳۹۹) مشاهده شد. گونه های علوفه‌ای بر اساس تعداد لقمه‌برداری شترها رتبه‌بندی شدند. بیشترین علوفه‌های مصرف شده از طریق مشاهده شناسایی شدند، سپس برای شناسایی نام‌های محلی و علمی نمونه‌برداری شد. پارامترهای کیفیت علوفه مانند: پروتئین خام (CP)، عصاره اتری (EE)، کلسیم (Ca)، فسفر (P)، فیبر شوینده خنثی (NDF)، فیبر شوینده اسیدی (ADF)، لیگنین مواد شوینده اسیدی (ADL) و ماده خشک قابلیت هضم (DMD) در آزمایشگاه تعیین شد. بیشترین گونه‌های علوفه‌ای مشاهده شده عبارت هستند از *Smirnovia iranica*، *Astragalus squarrosus*، *Nitraria schoberi*، *Haloxylon persicum*، *Seidlitzia rosmarinus* در فصل مرطوب و *Stipa barbata*، *Artemisia sieberi*، *Zygophyllum eichwaldii*، *Stipagrostis plumosa* و *Alhaji persarum* در فصل خشک. برای پروتئین خام بیشترین مقدار ۲۵/۷ و ۱۷,۹٪ به ترتیب در *Stipagrostis plumosa* و *Astragalus squarrosus* بدست آمد و برای DMD٪ ، بیشترین مقادیر ۷۲/۰، ۸۶/۶ و ۷۶/۶، به ترتیب در برگ *Artemisia sieberi* و *Stipa plumose* و *Haloxylon persicum* به دست آمد. نتایج این مطالعه نشان داد که کیفیت علوفه در فصل مرطوب بسیار بیشتر از فصل خشک بود و شترها از انواع مختلف گونه‌های علوفه‌ای علوفه تغذیه می‌کردند و ارزش غذایی علوفه‌ها می‌تواند بر انتخاب آنها تأثیر بگذارد.

کلمات کلیدی: ارزش غذایی، قابلیت هضم، بیابان، بوته