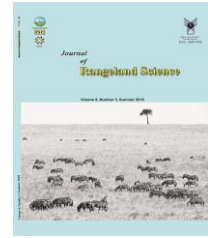


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**Research and Short Length Article:**

## **Forage Quality of *Calligonum comosum* in Three Phenological Growth Stages (Case study: Kashan Rangelands, Iran)**

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**Abstract.** Determination of forage quality of plant species in natural habitats such as rangelands and deserts is one of the most important factors for grazing management of these ecosystems. For this purpose, the nutritional values of *Calligonum comosum* in three phenological stages (vegetative growth, flowering, and seedling) were determined in desert habitats located in the northeast of Kashan, Iran (in 2017). Plant samples were collected from five plants as a replication in each phenological stage and the forage quality indices including Crude Protein (CP), Acid Detergent Fiber (ADF), Crude Fiber (CF), Dry Matter Digestibility (DMD), Total Energy (TE) and Metabolic Energy (ME) were determined. The results of ANOVA showed a significant effect of phenological stages on CP and TE ( $P < 0.01$ ) and DMD and ME ( $P < 0.05$ ). Higher and lower values of CP, DMD, TE and ME were obtained in vegetative growth and seed maturity stages, respectively. For these traits, there were no differences between flowering and vegetative growth stages. In contrast, higher and lower values for ADF were obtained in seed maturity and vegetative growth stage, respectively. It was concluded that the *Calligonum comosum* had higher quality in flowering and vegetative growth stages than that for seed maturity stage. Therefore, the flowering stage was considered as the best stage for grazing of this plant species.

**Key words:** Phenological stages, Desert habitats, Forage quality, *Calligonum comosum*

## Introduction

Rangelands are the largest dry areas on the planet and they cover a significant area in Iran. This vast area is considered as one of the main sources of the country's forage production and has an important role in livestock nutrition. Rangeland's forage production changes in quality from time to time and from place to place and species to species. These widespread changes and the causative factors are numerous and complex, but in general, the factors that affect the changes of forage quality are divided based on different environmental conditions (light, temperature, soil, rainfall, altitude, wind and humidity), growth stage, harvest time, diversity of plant species and management factors (Dongmei *et al.*, 2005).

Different plant species have different nutritional values and different plant types also have variable plant composition, so the determination of the grazing capacity based on 1.5 or 2 kg of dry forage in all vegetation types and habitats of the country 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). Determination of forage quality of rangeland's species and determination of rangeland grazing capacity to proper management of rangelands and the establishment of a sustainable balance between livestock and rangeland are very important (Arzani *et al.*, 2009; Kaboli, 2001). They believe that CP, DMD and ME are the appropriate factors for assessing the forage quality.

*Calligonum comosum* is from Polygonaceae family. It is adapted to desert conditions in sandy lakes as a species that is resistant to drought and dehydration. This plant has a good distribution in different conditions of dry and semiarid climate, especially sandy hills and its dissemination range is very

wide. It is present in most of Iran's central sandy soils such as Kerman, Khour and bibanbak, Nain, Dasht-e-Kavir, Damghan, Kashan, Sistan and Baluchestan (Batooli, 2011). Vegetative period of this plant begins from March, and the emergence of leafy leaves extends to mid-April, its tiny and white flowers begin to form in late March and by the end of May and give a very sophisticated landscape to the faces of the sandstones. Fruits appear in June and the height of the plant varies between 1 to 3 m (Batooli, 2011). Awareness of forages quality of this species is an effective way in timely use of them, anticipating food shortages and nutritional supplementation requirements for livestock. The purpose of this study was to determine the chemical composition and nutritional value of *Calligonum comosum* for feeding livestock at grazing plan and examining its quality at different phenological stages.

## Materials and Methods

The study area located in the northeast of Kashan, Iran in the geographical distribution of 59°29'45"E and 34°14'20"N with the area of 6500 ha. The elevation of the area is 912 m. The average annual rainfall in the region is 110 mm and annual evapotranspiration potential is 2400 mm. The average annual temperature is 22°C. The climate type of the study area by the modified Domaten method is dry and soil area is aridisol with low groundwater level. The presence of salt and gypsum in the soil is the edaphic characteristic of habitat from this plant species (Kaboli, 2001).

Samples of aerial parts of *Calligonum comosum* were collected in 2016 randomly from five individual plants in three phenological stages (vegetative, flowering and seedling). Samples of each phenological stage were mixed and dried in an oven at 70°C. The dried samples were grinded by a mill and then, forage quality indicators including TE by

calorimeter bomb device, CP with a Kjeldahl method and CF and ADF by Fibertec device were measured.

DMD and ME were calculated by equations 1 and 2, respectively (Van Soest, 1970)

$$\%DMD=83.58 - 0.824\% ADF+ 2.628\% N$$

$$ME(Mj/Kg/DM) =0.17\% DMD-2$$

Data were analyzed in one way ANOVA using SPSS software. Means comparisons of three phenological stages were made using Duncan test.

## Results

The results of ANOVA showed a significant effect of phenological traits on CP and TE ( $P<0.01$ ) and DMD and ADF and ME ( $P<0.05$ ) (Table 1). The results of means comparison of CP showed that higher values of CP were obtained at vegetative stage (20.30%) and flowering stage (19.25%) and there were no significant differences between them. But lower value of CP was obtained in seed maturity stage (16%) that was significantly lower than both vegetative and flowering stages (Fig. 1). For DMD, the mean values of 76.3%, 74.5% and 73.0% were obtained in vegetative, flowering and seedling maturity stages,

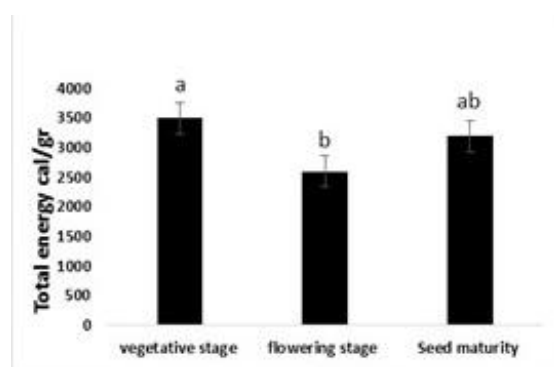
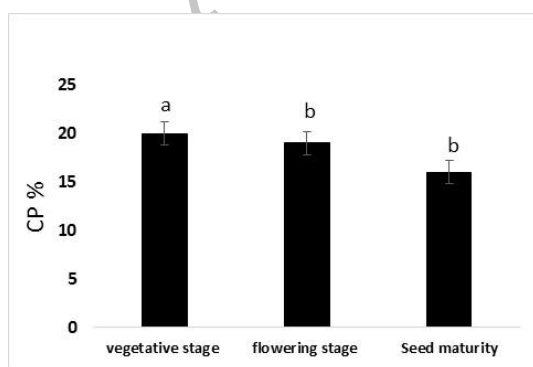
respectively (Fig. 1) indicating that DMD values were decreased by plant growth to seed maturity. For TE, higher and lower values of 3496 and 2615 Ca/g were obtained in vegetative and flowering growth stages, respectively ( $P<0.01$ ). TE value in seed maturity stage was 3281Ca/g that had a significant difference with both vegetative and flowering stages (Fig. 1). For ME, the mean values of 11.34, 10.26 and 10.83 MJ/Kg were obtained in vegetative, flowering and seedling maturity stages, respectively ( $P<0.05$ ); there was no significant difference between flowering and seedling stages (Fig. 1).

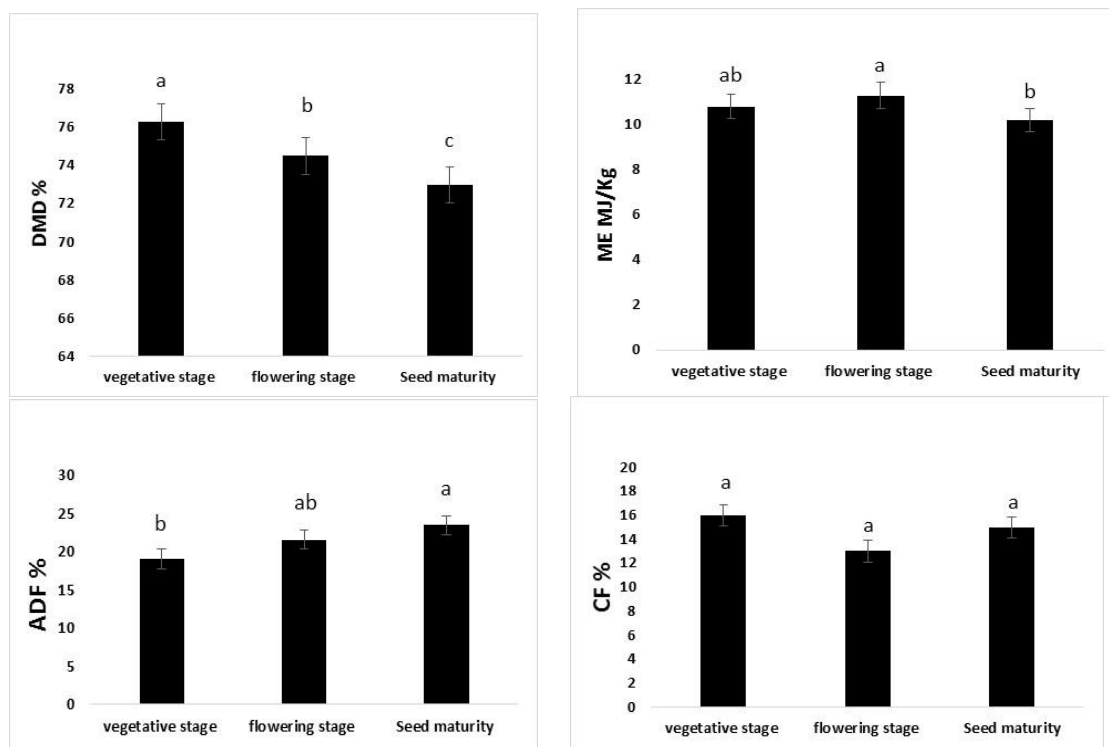
The reverse results were obtained for ADF and CF. Results of means comparison of ADF showed that mean values of 19.1%, 21.6% and 23.6% were obtained in vegetative, flowering and seedling maturity stages, respectively. For CF, there was no significant difference between three phenological stages. The CF values in vegetative, flowering and seedling stages were 15.96%, 13.14% and 15.20%, respectively (Fig. 1).

**Table1.** Analysis of variance of six quality traits in *Calligonum comosum* in three phenological stages

Source of variation	df	MS					
		CP	DMD	ME	TE	ADF	CF
Phenological stages	2	104.32**	28.40*	0.69*	1565581**	14.32*	31.08 <sup>ns</sup>
Error	25	6.52	4.78	0.125	217695	3.986	5.35

ns\* and \*\*= non-significant and significant at 5 and 1% probabilities levels.





**Fig.1.** Mean and standard deviation of six quality traits in three phenological stages  
Mean of column with the same letters has no significant differences based on Duncan method.

## Discussion

The results of this study showed that CP had the lowest mean values at seed maturity stage and there was no significant difference between vegetative and flowering stages. On the other hand, the DMD and ME at vegetative and flowering stages had higher mean values than seed maturity stage ( $P < 0.05$ ). For ME, the flowering stage had slightly higher values than the vegetative growth stage. According to the result of this research, we can say that *Calligonum comosum* has a higher quality in the flowering and vegetative growth stages than the seed maturity stage, but based on total indicators, the flowering stage can be considered as the best time for grazing this plant species.

According to the results of this study, the forage quality of *Calligonum comosum* was different in three stages of growth since the plant age increases, CP, ME and DMD were decreased leading to the reduced forage quality. Different plant species in the early stages of their growth have more water and it may be

selected by livestock. Among the various compounds in forage, ADF is one of the best indicators of forage quality in different plant species (Graber, 1991). In general, the highest quality is related to flowering stage and the lowest quality is related to seed maturity stage. Oddy *et al.* (1993) in their studies concluded that the rate of CP in plants in the vegetative stage was higher than the flowering and seed maturity stages; also, according to Larbi *et al.* (2011) studies, the amount of DMD and ME decreased with increasing the plant age.

Following the growth of the plant, the amount of firming and preserving tissues such as sclerenchyma tissue in the plant increases; these tissues mainly consist of building carbohydrates such as cellulose, hemicellulose and lignin. So when plant growth is complete, the number of structural carbohydrates in the plant and the ADF percent are more likely to increase while the CP concentration decreases. It is very important to be aware of nutritional values of plant species in their phenological stages. Hyder and

Sneva (2003) stated that with the knowledge of these cases, the best time of livestock grazing can be determined according to the forage quality. The result of this study showed that during the growth stages, the quantitative changes of ADF were visible; this result is consistent with the studies of Le Houérou (1994). It was concluded that the *Calligonum comosum* had higher quality in flowering and vegetative growth stages than seed maturity stage. Therefore, the flowering stage was considered as the best stage for grazing this plant species.

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## تعیین کیفیت علوفه گیاه اسکنبیل در سه مرحله رشد فنولوژیکی (مطالعه موردی: مراتع بیابانی کاشان)

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**چکیده.** تعیین کیفیت علوفه گونه‌های گیاهی در رویشگاه‌های طبیعی نظیر مراتع و بیابانها یکی از فاکتورهای ضروری جهت مدیریت صحیح این اکوسیستم‌ها می‌باشد. به این منظور ارزش غذایی گیاه اسکنبیل در سه مرحله فنولوژیکی (رشد رویشی، گلدهی و بذردهی) در رویشگاه‌های بیابانی واقع در شمال شرقی کاشان در سال ۱۳۹۶ مورد مطالعه قرار گرفته است. در مطالعه حاضر از هر مرحله فنولوژیکی، پنج پایه گیاهی انتخاب شد و پس از برداشت بخش هوایی، شاخص‌های کیفیت علوفه شامل پروتئین خام (CP)، دیواره سلولی منهای همی سلولز (ADF)، الیاف خام (CF)، قابلیت هضم ماده خشک (DMD)، انرژی کل (TE) و انرژی متابولیسمی (ME) اندازه گیری شد. نتایج نشان داد که تفاوت بین مراحل فنولوژیکی برای صفات TE, CP, DMD, ME از لحاظ آماری معنی‌دار بود. بیشترین و کمترین میانگین صفات فوق به ترتیب در مرحله رشد رویشی و بذردهی بدست آمد با وجود این از لحاظ آماری تفاوت معنی داری بین مرحله رویشی و گلدهی مشاهده نشد. در مقابل، بیشترین و کمترین میانگین درصد ADF به ترتیب در مرحله بذردهی و رشد رویشی بدست آمد. بر اساس نتایج این تحقیق می‌توان گفت که گیاه اسکنبیل در مراحل گلدهی و رشد رویشی کیفیت بهتری نسبت به مرحله بذردهی دارد، اما بر اساس کل شاخص‌ها کیفی مرحله گلدهی با توجه به افزایش رشد گیاه به عنوان بهترین زمان برای چرای این گونه گیاهی توصیه می‌گردد.

**کلمات کلیدی:** مراحل فنولوژیکی، رویشگاه بیابانی، ارزش غذایی، اسکنبیل