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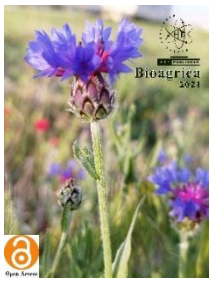

Forage quality variations of two halophyte species, at three phenological stages in marginal rangelands of Meighan Playa, Iran

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Abstract

This study was conducted to compare the forage quality of two native halophyte species *Camphorosma monspeliaca* and *Limonium iranicum* collected from Meighan saline rangelands near Arak city in central Iran. Edible biomass of both species was sampled on three phonological stages (vegetative growth, full flowering, and seed ripening). Forage quality indices such as Crude Protein (CP), Dry Matter Digestibility (DMD), Dry Matter Intake (DMI), Metabolizable Energy (ME), Acid Detergent Fiber (ADF), Neutral Detergent Fiber (NDF), and Phosphorus (P) were evaluated. The results showed significant differences ($p<0.01$) between species and phenological stages. *L. iranicum* had the highest CP (14.62%) in the vegetative stage while *C. monspeliaca* had the lowest CP (5.39%) in the flowering stage. *C. monspeliaca* also exhibited the highest Relative Feeding Value (RFV=135.9), which was significantly different from that of *L. iranicum*. In both species, the CP, DMD, and ME were decreased with progressing phonological stages while ADF and NDF, increased.

1. Introduction

There are about 163 halophyte and salt-tolerant species in Iran 53% of them belong to the Chenopodiaceae family (Ahmadi *et al*., 2005). These plants play an important role as feed resources for livestock in saline marginal rangelands of central Iran. Saline areas and marginal rangelands that are covered with halophyte shrubs have a great role in supplying forage for livestock as winter rangelands (Ahmadi *et al*., 2010). Halophytes and salt-tolerant forages yield low to high edible biomass in saline lands where nonhalophyte species cannot grow (El-Shaer, 2010). Halophyte plant species vary considerably in their nutritive value (Jafari, 1994). Information on the forage quality of halophytes in each phenological stage could help range managers choose suitable plant species for cultivation and also determine suitable grazing time to achieve higher animal performance in saline rangelands (Arzani *et al*., 2001). Knowledge of the nutrient content of forage is useful for the determination of rangeland capacity and the appropriate timing for the entrance of animals into rangeland. In addition, knowledge of the nutritional value of forage in different phenological stages can be helpful for range managers to select suitable grazing times and stocking rates to extract maximum performance without damaging the existing vegetation.

Factors that affect forage quality include species, growth stage, leaf-to-stem ratio, soil agents, climate, harvesting, diseases, and pests (Arzani *et al.*, 2001). The most important factor influencing forage quality is the growth stage (Arzani *et al*., 2001). Among various common chemical determinations of plant materials, Crude Protein (CP), Dry Matter Digestibility (DMD), and Metabolizable Energy (ME) are mainly considered for the evaluation of forage quality. The potential feeding value and the nutritive characteristics of available browses in the natural rangelands of salty arid regions remain poorly investigated (El-Shatnawi & Mohawesh, 2000). So, the objective of this study was to assess the forage quality of two halophyte species growing in Meighan saline rangelands, in Arak, Iran.

2. Materials and methods

The research was conducted at marginal rangelands of Meighan playa near Arak, Iran (49°50 E' and 34° 9' N), at an elevation of 1650 m (Figure. 1). Climatically, the rainfall in the studied region is around 270 mm, and the mean annual temperature is about 14.7 °C. (Heidarzadeh *et al*., 2020). The site is characterized by flat topography halophytes and salt-tolerant botanical composition. The climate of the area is characterized as semi-arid with cold winters. The soil texture is clay to sandy-clay-loam. Plant samples were harvested from two species of Meighan saline rangelands included:

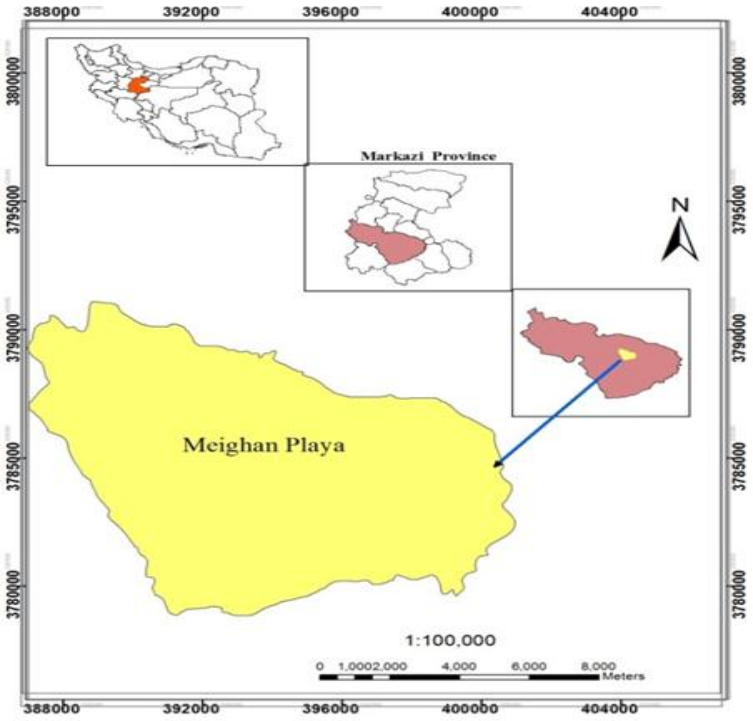

Figure. 1. The geographical location of study area.

Camphorosma monspeliaca (*Chenopodiaceae*) and *Limonium iranicum* (*Plumbaginaceae*). These plants are relatively palatable for domestic animals (sheep and goats). The edible biomass of both species was sampled by clipping the above ground biomass at a height of 2 cm above-ground level on three phonological stages (vegetative growth, full flowering, and seed ripening). All samples were oven-dried to 70°C for 24 h, milled to pass through a 0.5 mm screen, and kept for subsequent chemical analyses (AOAC, 2000). For forage quality evaluation, CP, DMD and ME, DMI, ADF, NDF, and phosphorus were determined. CP was determined by the

Kjeldahl method (N x 6.25), and NDF and ADF were measured by Van Soest (1963). DMD was estimated using Oddy *et al*. (1983): as DMD%=83.58−0.824ADF%+2.626N%. The ME was predicted with the equation ME= 0.17 DMD% -2, (AOAC, 1990). The Relative Feeding Value (RFV) was calculated as DMD multiplied by Dry Matter Intake (DMI) divided by 1.29 (Undersander and Moore, 2008).

The collected data were statistically analyzed using a split plots design based on a completely randomized design with three replications. Two factors were phonological stages and species. The means comparisons were made using the DMRT method using SAS software.

3. Results and Discussion

The results of the analysis of variance showed significant differences ($p<0.01$) between species and phenological stages (Table 1). *L. iranicum* had the highest CP (14.62%) in the vegetative stage while *C. monspeliaca* had the lowest one (5.39%) in flowering stage. In both species, the values of CP, DMD, and ME decreased with progressing phonological stages while ADF and NDF, increased (except for th eseed ripening stage of *C. monspeliaca*. For phosphorus contents, the *C. monspeliaca* had higher phosphorus values (0.08%) than that the other species. There were also significant differences in ME and DMI between species in which *C. monspeliaca* had the higher ME but *L. iranicum* had a higher DMI. In addition, the maximum values of DMD were belonged to *L. iranicum* in the vegetative stage (67.33%).

TABLE 1. The interaction effects between the phenological stage and two forage species in quality traits.

Species name	Phenological stage	CP%	ADF%	NDF%	P%	DMD%	ME5%	DMI	RFV
C. monspeliaca	Vegetative	11.43^{b}	30.64^{e}	41.93^{d}	0.070^{d}	65.03^{b}	9.05^{b}	2.86^{c}	144.26^{c}
	Flowering	5.39^{f}	37.89^{c}	47.60^{c}	0.077^{c}	59.38^{d}	8.09^{d}	2.52^{d}	116.05^{d}
	Ripening	5.61^{e}	31.63^{d}	40.53^{e}	0.100^{a}	64.26^{c}	8.92^{c}	2.96^{b}	147.48^{b}
L. iranicum	Vegetative	14.62^{a}	27.68^{f}	23.92^{f}	0.060^{e}	67.33^{a}	9.44^{a}	5.01^{a}	261.81^{a}
	Flowering	8.57^{d}	54.68^{b}	56.15^{b}	0.079^{b}	46.30^{e}	5.87^{e}	2.13^{e}	76.71^{e}
	Ripening	10.51^{c}	72.34^{a}	72.65^{a}	0.077^{c}	32.54^{f}	3.53^{f}	1.65^{f}	41.67^{f}

Different letters indicate significant differences at ($P < 0.01$).

The fodder quality of halophyte plants depends on a combination of climate, soil, and plant factors. Halophytes have the advantage of tolerating high salt levels in saline lands and have economic potential in arid and semi-arid areas (Sharifi Rad *et al*., 2013). These authors, also, reported that with the advancing maturity of halophytes, the contents of silica, Cell Wall Constituents (CWC), cellulose, and lignin increased while CP, phosphorus, and gross energy decreased. The reduction in the rate of DMD associated with plant aging is likely due to the increase in the proportions of structural to non-structural carbohydrates. Arzani *et al*. (2006) also reported that with the progress of plant growth, structural carbohydrates such as celluloses, hemicelluloses, and lignin, are increased. Therefore, the maturity of plants and an increase in structural carbohydrates cause higher fiber amounts in forage.

The results of the present study showed that with a progressing growth stage, CP, DMD, and ME were reduced. The results are similar to results obtained by (Panahi *et al*., 2012; Arzani *et al*., 2004; El-Shaer, 2010; Uzun, 2010, Esfahan *et al*., 2010; Ahmadi *et al*., 2005). According to Arzani *et al*. (2004), the reduction of DMD and ME with the maturity of plants is due to increasing structural tissues in stems. Of course, DMD and ME of *C. monspeliaca* were higher in

the seed ripening stage; Arzani *et al*. (2004) and Panahi *et al*. (2012) stated that increasing DMD and ME in some species when seeds are matured is due to relatively high amounts of digestible carbohydrates in seeds. ADF and NDF contents increased with plant maturity, too. Panahi *et al*. (2012) also reported that ADF and NDF increased with plant growth in three Salsola species.

Sharifi Rad *et al*. (2013) believed that quality and nutritional value are directly related to CP, DMD, and ME in plants and tend to show opposing trends to ADF and CF agreeing with our results. In this study, forage quality was highest when both halophytic species were in the vegetative stage, decreasing dramatically as the plants matured. Based on RVF, *C. monspeliaca* had higher forage quality than *L. iranicum* in the flowering and seed ripening stage. Uzun (2010) found that the RFV of Hordeum bulbosum was significantly affected by the stage of maturity; as the plant matured RFV decreased.

Supplementary feeding, particularly with energy supplements, is recommended for small ruminants grazing such halophytes during dry seasons and prolonged drought periods (3). *L. iranicum* had a higher CP level which could cover the N requirements of grazing animals. In our study, CP and ME contents were sufficient to meet ewes maintenance and lactation requirements during any time of the year. Phosphorus was deficient for ewes, suggesting supplements would be necessary to adjust the high Ca/P ratio in their diet. Ewes require 7 to 9% CP for maintenance and 10 to 12% for lactation. They also need 0.15% to 0.20% P for maintenance and 0.25 to 0.30% for lactation (Holechek *et al*., 2001). El-Shantawi and Mohawesh (2000) reported that the introduction of saltbush (*Atriplex halimus* L.) into the semiarid grassland of Jordan would elevate the nutritive plain of livestock and possibly minimize the need for grain supplements during summer and autumn.

The nutrient value of rangeland forage depends on plant composition and stage of growth. The close matching of nutrient requirements and feed quality is necessary for efficient animal production. This study suggests that adequate nutrients are available in vegetation communities including the evaluated species. Results indicate the high potential of marginal rangelands of playas in supply forage for endemic races of goats and sheep in central deserts of Iran especially in autumn and winter as the most suitable period for animal grazing.

4. Conclusions

The results support the good potential of halophytes and salt-tolerant plants as sources of livestock fodders and arid and semi-arid rangelands improvement. Many halophytes could be considered as potential sources of nitrogen and or major minerals for sheep and goats fed on low-quality diets. However, energy supplementation of halophytes-containing diets is necessary to overcome the nutrient requirements of animals. Such salt-tolerant plants could be used successfully and safely as good quality winter fodders to solve the problems of feed shortage during summer and autumn seasons and, also, to increase the economic benefits of the marginal saline resources in Iran for local communities that need to be further explored and developed. Our findings showed that these halophyte species contain reasonable CP levels which could provide N requirements of grazing animals whereas Phosphorus was deficient for sheep, suggesting supplementary feeding.

References

Ahmadi, A., Arzani, H., & Jafari, A. A. (2005). Determination and composition of Forage Quality of Five Species in Different Phenological Stages in Alborz Rangelands. In: XX International Grassland Congress, Ireland, p. 292.

Ahmadi, A., & Sanadgol, A. A. (2010). Nutritive value of Zandi sheep diets (halophyte plants) grazing on Abbass Abad desert rangelands (Qom), Jour. Range and Watershed Management, Iranian Jour. Natural Resources, 63(3), 1-9.

AOAC, (2000). Official Methods of Analysis of the Association of Official Analytical Chemists. 15th ed. Washington D.C. USA.

Arzani, H., Torkan, J., Jafari, M. & Nikkhah, A. (2001). Investigation on effects of phenological stages and environmental factors (soil and climate) on forage quality of some important range species. Jour. Agricultural Science, 32, 385-397

Arzania, H., Basirib, M., Khatibib, F. & Ghorbani, G. (2006). Nutritive value of some Zagros Mountain, rangeland species, Small Ruminant Research 65, 128–135.

El-Shaer, H. M. (2010). Halophytes and salt-tolerant plants as potential forage for ruminants in the Near East region, Small Ruminant Research, 91, 3–12.

El-Shatnawi, M. K., Mohawesh, & Y. M. (2000). Seasonal chemical composition of saltbush in semiarid grasslands of Jordan. Jour. Range Manage. 53, 211–214.

Esfahan, E. Z., Assareh, M. H., Jafari, M., Jafari, A. A., Javadi, S. A. & Karimi, G. (2010). Phenological effects on forage quality of two halophyte species Atriplex leucoclada and Suaeda vermiculata in four saline rangelands of Iran. Jour. Food, Agriculture and Environment, 8, 999-1003.

Haddi, M. L., Arab, H., Yacoub, F., Hornick, J. L., Rollin, F. & Mehennaoui, S. (2009). Seasonal changes in chemical composition and in vitro gas production of six plants from Eastern Algerian arid regions, Livestock Research for Rural Development, 21(4), 1-16.

Heidarzadeh, M., Abdi, N., Varvani, J., Ahmadi, A. & Toranjzar, H. (2020). The effect of Typha Latifolia L. on heavy metals phytoremediation at the urban wastewater entrance to the Meighan wetland, Journal of Applied Research in Water and Wastewater. 7 (2), 167-171.

Jafari, M. (1994). The characteristics of salinity plants and halophytes, Research Institute Range and Forest publication, Tehran, Iran, 56 pp.

Panahi, F., Assareh, M. H., Jafari, M., Jafari, A. A., Arzani, H., Tavili, A. & Zandi Esfahan, E. (2012). Phenological Effects on Forage Quality of Salsola arbuscula, Salsola orientalis and Salsolatomentosa in Three Habitats in the Central Part of Iran, Middle-East Jour. of Scientific Research 11(6), 800-807.

Sharifi Rad, M., Sharifi Rad, J., Jaime, A., Silva, T., & Mohsenzadeh, S. (2013). Forage quality of two halophytic species, Aeluropus lagopoides and Aeluropus littoralis, in two phenological stages, International Jour. Agronomy and Plant Production, 4(5), 998-1005.

Undersander, D., Moore, J. E., & Schneider, N. (2002). Relative forage quality. Focus on forage, 4(5), 1-2.

Uzun, F. (2010). Changes in hay yield and quality of bulbous barley at different phenological stages, Turkish Jour. Agriculture forestry 34, 1-9.