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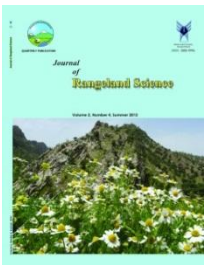

Full Length Article:

Estimation of Nutritive Values of Some Range Species as Indicators for Rangelands Management

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Abstract. Information on different rangeland plants' nutritive values during various phonological stages is of importance for the rangelands management. This information helps rangeland managers to choose proper grazing times to achieve higher animal performance with no detrimental effects on the rangeland vegetations. Effects of various plant parts' phenological stages and vegetation types on reserve carbohydrates and forage quality indicators were investigated during 2009 and 2010 in Sabzkooh rangelands at Charmahal province, Iran. Plant samples were collected based on a Completely Randomized Design (CRD) at 3 phonological stages (seedling, vegetative and flowering) with 5 replications. The species included grasses (*Secale montanum* and *Festuca ovina*), forbs (*Lotus corniculatus* and *Sanguisorba minor*) and shrubs (*Kochia prosterata* and *Salsola rigida*). Aerial plant parts' samples were harvested and oven-dried at 80^{o}C for 24 hours; then, they were analyzed for determining the amounts of Water Soluble Carbohydrates (WSC), Crude Protein (CP), Acid Detergent Fiber (ADF), Dry Matter Digestibility (DMD) and Metabolic Energy (ME). Results showed that forbs contained more WSC as compared to the other two vegetation types (grasses and shrubs). For other forage quality traits (CP, DMD, and ME), there were significant differences between species over two years and higher and lower forage qualities were obtained for forbs and shrub, respectively. For WSC, *Sanguisorba minor* and *Lotus corniculatus* had the highest values while *Secale montanum* and *Salsola rigida* had the lowest WSC content.

Key words: Soluble carbohydrate, Protein, Digestibility, Vegetation types (Forb, Grass and Shrub).

Introduction

Studying the nutritive values of rangeland plants used for feeding the livestock and information on the effects of the environmental conditions on changing the forage quality are very important in the rangelands management. Also, information on the forage feeding value is essential for rangelands management because the forage feeding value varies in different conditions (Biondini *et al*., 2006; Graza and Fulbright, 2008; Low and Andrews, 2007; Dongmei *et al*., 2005). On the other hand, the nutritional needs of the animals are different in various environmental conditions and at different phenological stages of plants (McDowell, 2005; Norton and Waterfall, 2000 Shinde *et al*., 2000; Underwood, 2001).

Researchers believe that several factors affect the forage feeding value. Sulc *et al*. (2009), Ayan *et al*. (2010) and White (2003) reported that the most important factor for the changes in the forage feeding value is the plant growth stage, and the forage plants have different feeding values at various phenological stages. Different rangeland plant species had been studied by several researchers and all of these investigators had reported that the differences in forage feeding values of various plant species resulted in the differences in animal metabolisms (Coyne and Cook, 1991; Davidson and Milthorpe, 1995; Graber, 1991; Deregibus *et al*., 2002; Hyder and Sneva, 2003). Some forage quality traits that affect the feeding values such as Water Soluble Carbohydrates (WSC), Metabolic Energy (ME), crude protein (CP), Acid Detergent Fiber (ADF) and Neutral Detergent Fiber (NDF) have been suggested as the first priorities by several investigators (Menke and Trlica, 1985a, 1993b; Moore and Biddingscomb, 1994; Orodho *et al*., 2000). Information on the forage composition that provides food reserves in the plants is very important for the rangers. The knowledge of how these compounds are made in the plants and in which plant parts they are more concentrated can greatly contribute to identify the appropriate grazing time, number of grazing livestock, and the length of grazing period. Physiological changes are different in range species because various species are different from each other in terms of growth rate, flowering time, type of the leaves, leaf to stem ratio and height.

Water Soluble Carbohydrate (WSC) content is a major factor affecting both plant growth and animal performance. Therefore, knowledge of carbohydrate accumulation, transport, storage and use in plants can help the rangeland managers to take proper care of the pasture plant species (Mikic *et al*., 2010; Richards and Caldwell, 2005). The most important factor for the balance of stoking rate and rangelands capacity is probably the knowledge about the forage quality to determine the capacity of a pasture. It is required to determine the forage nutritive value because animal performance in the grazing season depends on the forage quality. This information helps the ranges to balance the available forage and the animal's nutrition needs, and applying these factors enables them to achieve maximum animal performance. The forage quality and its feeding value are affected by several factors including vegetation stages, grazing intensity and plant species. Therefore, the objective of this study was to compare the forage quality traits in three vegetation types (grasses, forbs and shrubs) in Sabzkooh rangelands at Charmahal province, Iran during 2009 and 2010.

Materials and Methods

Plant materials and sample collections. The study was conducted in Sabzkooh rangelands at Charmahal province in south western of Iran. The climate of this region

has been specified as moderate semiarid using Emberger method (Xerophilous forest zone). In this study, six range species were investigated. The species included two grasses (*Secale montanum* and *Festuca ovina*), two forbs (*Lotus corniculatus* and *Sanguisorba minor*) and two shrubs (*Kochia prosterata* and *Salsola rigida*). Sampling data were collected from five replicated plots which contained five plants. Therefore, 25 plants were harvested for each species during the flowering stage. The samples were air dried in the shade at room temperature. In sample collection for WSC, since the respiration and photosynthesis may continue after the clipping for a few minutes and this affects the soluble carbohydrates, the plant materials were placed in a mobile freezer, and the frozen plant samples were used for chemical analyses. Then, plant materials were placed in the oven and dried at 80°C for 24 hours. Then, the dried samples were ground. The sampling was repeated in the second year. The sampling period in the second year started a few days later because the plants' growth was started late in the second year.

Measurement of chemical compounds: For the measurement of the WSC, the Phenol-H_2SO_4 (Sulfuric Acid) method was used. In this method, 0.5 g dried plant sample was taken and 15 ml Ethanol (80%) was added. Then, it was heated at 75°C for 5 minutes by a heater and centrifuged at 3000 rpm for 10 minutes. Then, the centrifuge was turned off and the clear solution in the flask was separated. This was repeated for two times. The aliquots taken from these two replications were mixed and placed in a 70-80°C oven for 1 h. Afterward aliquots volume was raised to 100 ml by adding distilled water. Next, 4.7 ml $Ba(OH)_2$ (Barium hydroxide) was added. After 3 minutes, 5 ml $ZnSO_4$ (Zink sulfide) was added and thoroughly mixed. A 35 ml of this thoroughly mixed solution was centrifuged at 3000 rpm for 10 minutes and 2 ml of this aliquot was used for Spectrophotometry at 485 nm. In this study, 2 ml H_2O and 2 ml H_2SO_4 were used for the control treatment. Data obtained with this method were on ppm (mg L^{-1}) units and the following formula was used to convert the data to carbohydrate in the plant dry material.

$$WSC\% = (\frac{V}{106DM}) \times 100$$

Where

V is the volume of the soluble carbohydrates obtained by spectrophotometry in ppm (mg kg^{-1}**)**, and DM is dry material (g) used for the measurement of WSC using this method.

Measurement of CP was conducted by the evaluation of the N content of the plants while it was assumed that all the proteins in the plants contained 16% nitrogen (16% N) and all the nitrogen was used for protein synthesis. Then, the following formula (Bidlock and Devald, 1999) was used to calculate the rate of CP.

$$CP\% = (\frac{100}{16x}) \times \%N = 6.25 * X\%N$$

Bidlock and Devald (1999) stated that this formula includes the non-protein nitrogen, too. Thus, the amount of the calculated protein is more than the actual protein using this formula. Therefore, the measurement of the CP content of the plants is overestimated. This method is known as Kjeldahl 2. To measure the ADF content of the plants, the Fibertec was used. For this purpose, 1 g of the ground sample was placed into the glass tubes in the Fibertec. Then, 100 ml ADS (Acid Detergent Solution) was added and boiled for 1 hour. For the preparation of the ADS, 20 g $BrNH_4(CH_3)_3$ (Three methyl bromide) was mixed with 10 ml H_2SO_4 (Sulfuric acid). After 1 hour, all the substances in the solution were disappeared except the cellulose, lignin and the minerals. Then,

the samples were washed with distilled water and acetone in the cold extraction device and placed in the oven at 120^{o}C for 2 hours. Afterwards, the sample weights were measured with a digital scale, and the samples were put in an electric furnace at 500^{o}C for 3 hours. In the electric furnace, all of the samples' cellulose and lignin were burnt and only the minerals were remained. The samples were taken out of the electric furnace and their weights were measured with a digital scale. By comparing the weights of the samples before and after putting in the electric furnace, the ADF was obtained using the following formula.

$$\text{ADF }\% = \left(\frac{(\text{Initial sample weight}) - (\text{Samples' weight after burning})}{\text{Initial sample weight (1g)}}\right) \times 100$$

This method of the ADF measurement is according to the AOAC (Association of the Official Analytical Chemists) formula.

DMD has been calculated through following formula (Fonnesbeck and Davidson, 1985).

DMD%= 88.9N-0.779ADF

Where:

DMD and ADF are dry matter digestibility and acide detergent fiber, respectively. Therefore, DMD is directly related to plant nitrogen (N) content and inversely related to plant ADF content.

After the DMD was estimated, the following formula was used to calculate the ME in MJ unit.

ME=0.17DMD%-2

Results and Discussion:

The results of the one-way analysis of variance (ANOVA) showed significant differences between species for CP, ADF, ME, and DMD, (P<0.01) (Table 1). In 2009, samples were taken from six species (three vegetation types). In 2010, samples were taken from four species (two vegetation types). The means comparisons of vegetation types for all the quality traits are presented in Figs. 1 and 2 for 2009 and 2010, respectively, In 2009, the higher and lower CP, DMD and ME values were obtained for forbs, grass and shrub, respectively (Fig. 1). In 2010, the same trend was continued and all three quality traits of CP, DMD and ME were high and low for forbs and shrubs (Fig. 1).

The mean values of the Metabolic Energy (ME) during 2009 and 2010 showed that these values were the same for the grass and forbs and the mean values of the shrubs were less than those of the grass and forbs in 2009. However, in the second year (2010), forbs had higher ME than the shrubs (Fig. 2). The mean values of DMD for various species were different in both years (2009 and 2010). Forbs had the highest mean of DMD in both years (2009 and 2010) and shrubs had the lowest (Figs. 1 and 2). In the first year (2009), grasses had the highest ADF values and forbs had the lowest (Fig. 1). However, since there were no data for the grass species in the second year (2010) and only shrubs and forbs were analyzed, shrubs had higher ADF than the forbs (Fig. 2).

The mean comparisons of six species for WSC are presented in (Fig. 3). The results showed significant differences between species (P<0.01) (Fig. 3). *Sanguisorba minor* in the first year (2009) and *Lotus corniculatus* in the second year (2010) had the highest WSC contents while *Salsola rigida* had the lowest in both years. Duncan Multiple Range test indicated that *Secale montanum* and *Salsola rigidula* had lower WSC content (Fig. 3).

Changes in the chemical composition of these six rangelands species showed that vegetation type is the most important factor affecting the forage quality. Therefore according to these results in order to improve the rangelands conditions and select a suitable grazing system and grazing time, two following factors are essential: a) place of food reserves in the rangelands' species and b) nutritive values

of plant species during the growth period in order to meet the nutritional needs of the animals and ensure the re-growth of the rangelands' plant species. The entry and exit of the animals to the pastures and animals' performance during the livestock grazing season are under the direct influence of soluble carbohydrate reserves in the rangelands species. Studying the vegetation cover types showed that forbs, grasses and shrubs have different carbohydrate reserve contents. Therefore, the rangelands where these three types of vegetation covers exist should be carefully managed. The forage quality indicators including DMD, ME, ADF and CP were different in various species. It seems that in different plant species, the main constituents of the plant structure such as leaf to stem weight ratio, leaves' arrangement, stem length and growth rate determine the quality of the plants.

Table 1. Analysis of variance and MS of species for four quality traits in 2009 and 2010

Year	SOV	DF	MS			
			CP%	ADF%	ME%	DMD%
2009	Species	5	267.7**	935.5**	9.6**	595.8**
	Error	72	0.531	2.02	0.931	1.22
	Coefficient of Variation (CV %)		5.91	4.54	6.99	1.71
2010	Species	3	150.6**	720.6**	16.4**	466.5**
	Error	48	0.134	0.381	0.207	0.189
	Coefficient of Variation (CV %)		2.86	1.92	5.24	0.68

**, Significant at the 0.01 probability level

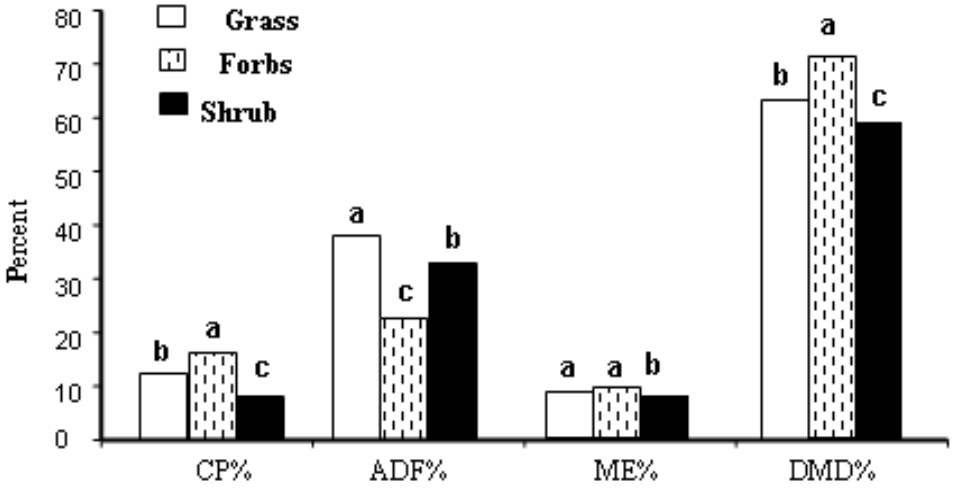

Fig. 1. The means comparisons of forage quality (CP, ADF, ME, and DMD) in three vegetation types (Forbs, Grass, and Shrub) in 2009

The means of the column for each quality parameters with same letters were not significantly different based on DMRT method $P<0.05$

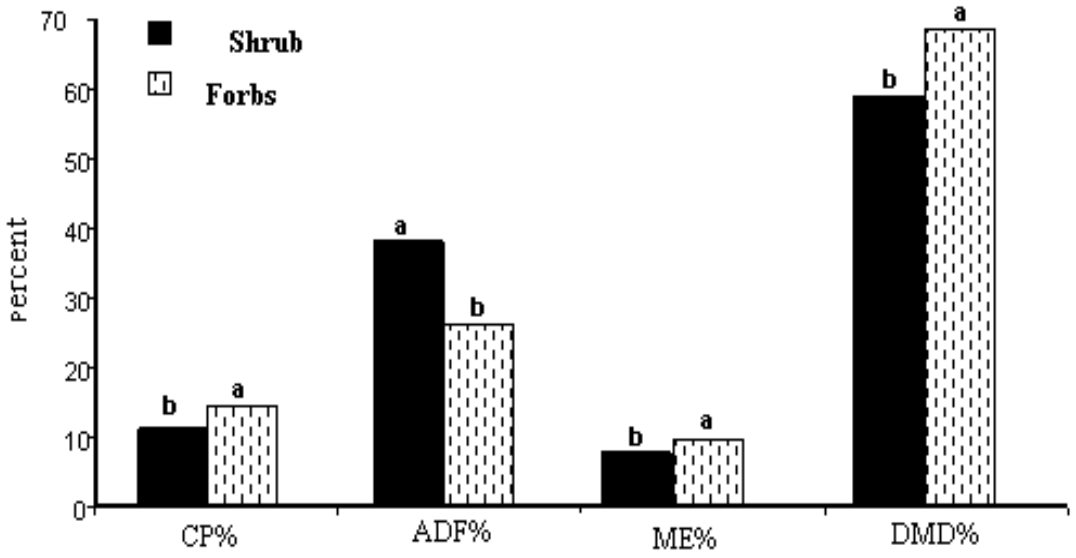

Fig. 2. Means comparisons of forage quality (CP, ADF, ME, and DMD) in two vegetation types (Forbs and Shrub) in 2010

The means of the column for each quality parameters with same letters were not significantly different based on DMRT method P<0.05

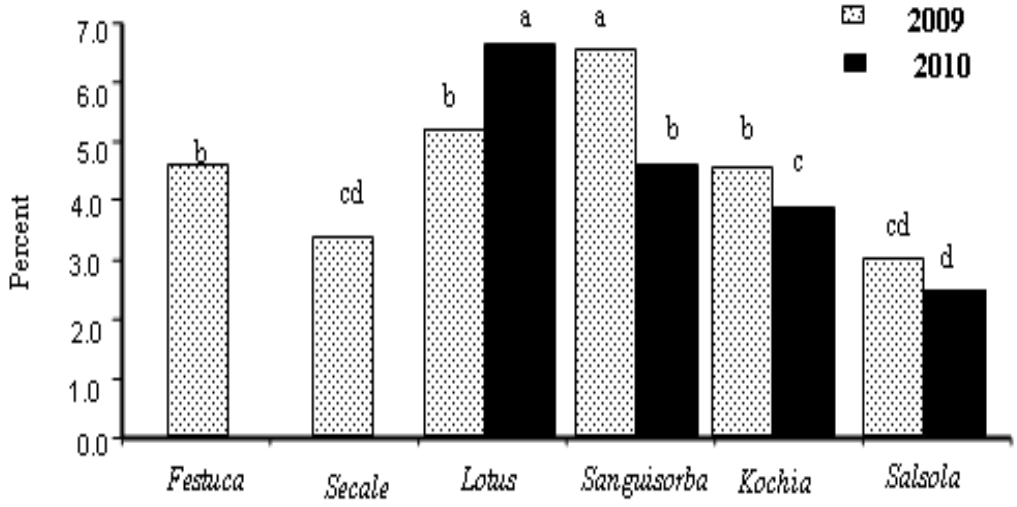

Fig. 3. Means comparisons of Water Soluble Carbohydrates (WSC) in six range species in 2009 and 2010

The means WSC for each species with same letters were not significantly different based on DMRT method P<0.05

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