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Forage quality of three life forms of rangeland species in semi arid and semi humid regions in different phenological stages

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Abstract

For determination of grazing capacity, information of forage quality is essential which is influenced by various factors. The main objective of this research was investigation on effects of species, phenological stages, and life form on values of forage quality indices of six range species. Species were two grasses (*Bromus tomentellus* and *Dactylis glomerata*), two forbs (*Ferula ovina* and *Coronilla varia*) and two shrubs (*Salsola rigida* and *Artemisia aucheri*). Samples were collected from two highland ranges of Gachsar and Vard Avar. They were dried, grained and analyzed in Laboratory. The results showed that forage quality indices values including crude protein (CP), acid detergent fiber (ADF), dry matter digestibility (DMD) and metabolizable energy (ME) were significantly differed among species, phenological stages, and life forms ($P<0.01$). For all species CP, DMD, and Me decreased and ADF increased with plant growth development. Considering forage quality indices values among six species, *C. varia* had highest forage quality. Among life forms, forbs, higher forage quality obtained from forbs. In terms of growth stage, vegetative growth stage had better forage quality.

Keywords: Forage quality; Growth stage; Crude protein; Acid detergent fiber; Dry matter digestibility, Metabolizable energy

1. Introduction

Determination of grazing capacity is essential for making balance between livestock and rangelands. For determination of grazing capacity forage quality information is required. Arzani et al. (2004) believed that forage quality directly affects animal requirement as a factor in grazing capacity estimation. In addition animal performance during grazing season depends on nutritional contents of available forage. Information of forage quality will help range manager to make balance between animal requirement and available forage to reach maximum animal performance.

Forage quality is influenced by various factors, among them stage of growth is the most important factor affecting nutritional contents of forage. It was also reported by (Dawayne 1994, Cabalero et al. 2001, Kaiser 2001, Rayburn 2002, Gustavason 2003, Kaboli 2001, and Arzani et al. 2004). Stiven et al. (1994) investigated on temperature effect on forage quality and found that effects of plant maturity is most serious on forage quality which is related to plant environment including temperature. They reported that in addition to temperature, other environ mental factors including solar radiation, soil characteristics, water and insects influence on forage quality, plant growth and its development, and plant productivity.

Buxton et al. (1996) stated that phenological stages are affected digestibility which is reduced by growth development because of stems

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growth and reduction in ratio of leaf to stem. Cabalero et al. (2001) reported variation of crude protein of forage in three phenological stages for *Vicia sativa*. Their results showed that fiber content of forage increased in maturity. Rayburn (2002) found that nutrient values of forage influenced by stage of growth, severity of grazing, and plant species. Among these, growth stage had been more important factor.

Forage quality also varies between plant parts (Arzani et al. 2004). Among leaf, stem and flower, quality of leaves is higher than other parts. According their results, forage with higher leaf ratio to stem is more desirable for animal. Therefore in vegetative growth stage when rate of leave in forage is higher than stem nutrient value is higher.

In rangelands with high plant diversity including various life forms of grasses, forbs and shrubs because of differences of spices phenology change of physical and chemical components are not similar among species and life forms. Cook (1972) compared nutrient components of three life forms of grasses, forbs and shrubs and found that shrub species had higher quality among life forms. However Arzani et al (2006) reported higher quality for forbs in Charmahal province of Iran. So the main objectives of present research were investigation on effects of life forms, growth stage and species on variation of quality indices.

2. Material and methods

2.1. Study area

Research was conducted in two regions of Vard Avard (semi-arid) and Gachsar (semi-humid). Vard Avard is located north of Tehran-Karaj free high way with area of 6435 hectares between 51° 4' to 51° 9' 52" east longitude and 35° 44' 33" to 35° 50' 57" north latitude. Based on 22 years climatic data of climatological stations near the region average annual rainfall ranged from 225 to 440 mm depends on altitude. Average annual temperature of Vard Avar is 16.5°^{C} in lowest altitude and 4.1°^{C} in highest altitude of catchments. Most samples were collected in 2400 m altitude where categorize as highland. Plant diversity is higher than other parts of region (Azarnivand 2003). Vegetation types are *Astragalus gossypinum-Agropyron tauri* and *Artemisia aucheri-Acantholimon festucacetum*. Accompany species were; *Bromus tomentellus*, *Kochia prosterata*, *Festuca ovina*, *Stipa barbata*, *Poa bulbosa*, *Psathyrostachys fragilis*, *Amygdalus lycioides*, *Salsola kali*, *Onopordon acanthium*, *Bromus dantoniae*, *Cotoneaster numularia*, *Eurotia ceratoides*, *Phlomis orientalis*.

In 2100 m above sea level samples of *Ferula persica* were collected from *Amygdalus scoparia_ Ferula persica* vegetation community. It was found mostly on sloppy areas. Some of accompany species were; *Eryngium compestre*, *Salvia limbata*, *Bromus tectorum*, *Scariola orientalis*, *Melica persica*, *Papaver roeas*, *Artemisia aucheri*, *Stachys inflata*, *Capparis spinosa*, *Dactylis glomerata*, and *Coronilla varia*.

Gachsar is located east and west of Chalus highway. Samples were collected between 2400- 2500 m above sea level in 51° 7' east longitude and 36° 7' north latitude. There were no climatological station, however precipitation of year that research was conducted was about 748 mm. Vegetation composition of the region was rich. Some of its plant species were; *Festuca arundinacea*, *Sanguisorba minor*, *Euphorbia sp*. *Phelomis ferulacea*, *Allysum strogosum*, *Poa bulbosum*.

2.2. Methods

The main objectives of this research were investigations on effects of phenological stages and life forms on range forage quality. Samples from six range plant species in three phenological stages of vegetative growth, flowering and plant maturity were collected. Samples were belonged to current year growth with 5 replicates. For each replicate 5 individual plants of each species were cut and mixed (25 individual plants for each species). Considering homogeneity samples of each species were collected in the vegetation community that that species was dominant. Samples were oven dried in 60°^{C} for 24 hours in laboratory and were ground to pass through a 40-mesh screen for chemical analysis.

Crude protein (N% * 6.25) was measured by Kjeldahl technique (AOAC, 1980) using a Kejeltec system. Acid detergent fiber and ADF was measured using the Fiber Tech System according to the AOAC (1980) procedure. Dry matter digestibility was estimated using the formula DMD% = 83.58 - 0.824 ADF% + 2.626 N% suggested by Oddy *et al.* (1983). Metabolizable energy was also predicted using the equation ME = 0.17 DMD% - 2 suggested by AOAC (1980).

Forage quality of species between growth stages and life forms were compared using One Way Analysis of Variance (ANOVA) based on complete random design. For understanding sources of changes within life forms and

comparison of species Dankan test was used in SAS version 6.1. Figures were prepared using Excel.

3. Results

Obtained results from analysis of variance showed that mean of all quality indices factors including CP, ADF, DMD, and ME differed between species (P<0.01). *Coronilla varia* had highest CP rate and lowest CP percentage was obtained from *Artemisia aucheri*. Similar percentage of CP was recorded for *Salsola rigida* and *Artemisia aucheri*. Among species *Ferula ovina* had highest percentage of ADF in third growth stage (45.9) while *Coronilla varia* had 16.03% ADF in the first growth stage as a lowest percent. In terms of ADF contents *Bromus tomentellus* and *Artemisia aucheri* were the same. Highest and lowest ME were recorded for *Bromus tomentellus* and *Dactylis glomerata* respectively. Based on the results of analysis of variance DMD% varied between species. *Coronlla varia* species had highest average of digestibility and *Dactylis glomerata* had lowest (Figure 1).

Chemical components of life forms were significantly difference (P<01). Among them forbs had more CP% and shrubs had lower CP%. Larger and smaller ADF percentage was measured in grasses and forbs respectively. Forbs contained more ME contents comparing with grasses and shrubs life forms (Figure 2).

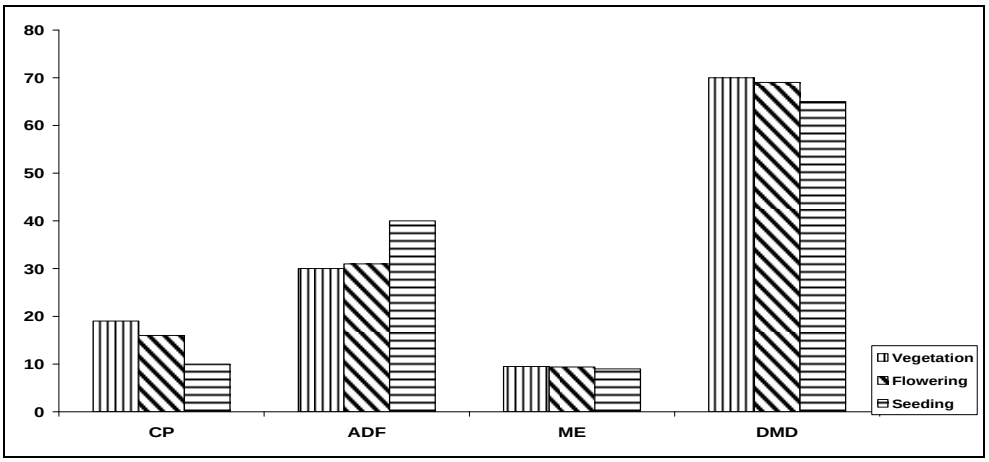

Fig.1. Mean of forage quality indices (CP%, ADF%, ME MJ/kg DM and DMD%) in different phenological stages (P<0.1)

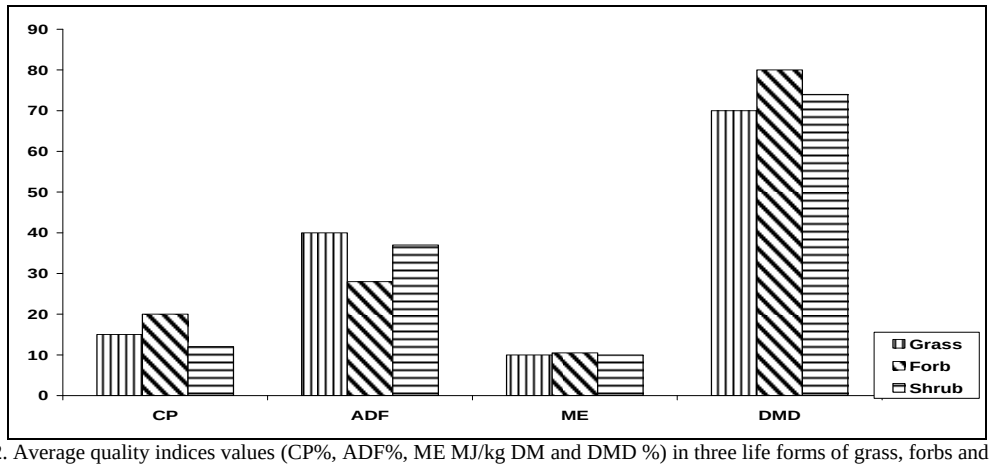

Fig. 2. Average quality indices values (CP%, ADF%, ME MJ/kg DM and DMD %) in three life forms of grass, forbs and shrub

4. Discussion and conclusion

Forage quality indices including CP, ADF, DMD, and ME varied between species. The main factors forming plant structure and influencing forage quality are; types of root system, leaves, stem length, speed of growth and growth period. Zohdi (2001), Kaboli (2001), Ahmadi (2003), found that forage quality is affected by species. It means that available energy to animals in each vegetation type depends on vegetation composition.

Because of morphological and physiological differences between life forms different

chemical components can be expected. Forbs species were more desirable than grasses and shrubs. This is in agreeing with findings of Arzani et al. (2006). However in the research area of Cook (1972) shrubs species had higher digestible protein than forbs and grasses. In addition of differences between life forms, differences between forage qualities of species within life forms also can be expected.

Changes in chemical composition of six range species during growth period showed that phenological stages had significant effects on forage quality of rangelands. This is similar to finding of other researchers such as (Vallentine 1990, Van Soest 1991, Torkan 1999, Cabalero 2001, Zohdi 2001, Erfanzadeh 2001 and Ahmadi 2004).

It is important in a grazing management plan, for determination of beginning and end of grazing consideration to phenological stages, plant composition and life forms is necessary. In selected suitable grazing system forage quality is desirable, and plant species health will be provided.

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