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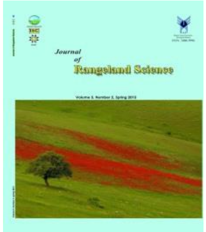

Research and Full Length Article:

Seasonal Changes of Nutritive Values and Digestibility of Range Forage of Chaharmahal and Bakhtiari Province, Iran

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Abstract. Range forage of *Vicia variabilis*, *Astragalus* spp., *Medicago sativa*, *Prangos uloptera* and *Sanguisorba minor* was sampled during three phenological stages from the controlled rangeland stations in Chaharmahal and Bakhtiari province, Iran. Samples were analyzed for the determination of Crude Protein (CP%), Ether Extract (EE), Crude Fiber (CF), total Ash, Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF), *in vitro* Dry Matter Digestibility (DMD) and Organic Mater Digestibility (OMD). Higher and lower values of CP were obtained in vegetative stage of *Medicago sativa* and seed ripening stage of *Prangos uloptera*, respectively. The highest and lowest values of EE% were found in *Prangos uloptera* and *Astragalus* spp. respectively. The highest and lowest values of CF% were obtained in the vegetative stage of *Prangos uloptera* and ripening stage of *Medicago sativa*, respectively. For NDF and ADF, the lower values were found in the vegetative stage of *Prangos uloptera* and *Sanguisorba minor*, respectively and higher values were observed in the seed ripening stage of *Asragalus* spp. and *Prangos uloptera*. The highest values of DMD and OMD% were obtained in the vegetative stage of *Vicia variabilis*, but the lowest values were found in *Medicago sativa* and *Sanguisorba minor* respectively. Both DMD and OMD% values were reduced from vegetation to seed ripening stage in all the species. It was concluded that it is necessary to pay attention to the seasonal changes in order to conduct the quality study and determine the nutritive value and digestibility of range plants. Use of energy and protein supplement in late period of range plant growth has been recommended for the supply of essential requirements of rangeland animals.

Key words: Seasonal changes, Range forage, Nutrient value, Digestibility, Iran

Introduction

In Iran, many features of the climate make range plant growth difficult and change them seasonally. They go beyond the low and variable precipitation, the intense solar radiation, high evaporation of summer, and the cold of winter. Over most of the country zones, the rainfalls are often violent and occur only at long intervals for a given amount of annual precipitation and the number of rainy days is relatively small (Nemati, 1977).

Chaharmahal and Bakhtiari province in the south west of Iran has semi-arid climate with annual precipitation of about 600 mm which distributed from early autumn to mid spring. This region has a long history of nomadic system and livestock grazing where most of the rural and nomad people depend on the socio-economical livestock rangeland system (Shadnoush, 2013). A high majority of the sheep and goat population is managed under migratory system while utilizing the ranges as the major source of feed. Furthermore, the feed availability with low quality from natural grazing may be limited and the periodic drought is also a constraint (Shadnoush *et al.*, 2004).

In this situation, the decreased performance of grazing animals with the consumed low energy intake due to high fiber content, low protein content of range plants and mineral deficiencies may be observed. For maintaining sufficient growth and reproductive performance, animal producers need to compare the nutritive changes of range forage (Ramirez *et al.*, 2004). Suitable improvement of grazing and balance nutrition system for livestock needs information of the nutrition value of range plants. However, there are few reports to quantify seasonal nutritive changes of the most important range grasses and forage consumed by range sheep and goats (Shadnoush, 2004; Shadnoush, 2013; Shakeri and Fazaeli, 2004). Therefore, the concept of matching small ruminant livestock production with the available feed resources needs the intensified research on the optimum use of local feeding resources.

Contemporary with the early vegetation in spring, range species are producing new foliage. During the end of summer and autumn, most of the species showed a reduction in the amount of nutrient while passing from vegetation to seed ripening stage (Ramirez *et al.*, 2004). The nutritive value of range plant depends not only on maturity or the growth of plants, but also on the climatic conditions and seasonal variations. Additionally, the nutrient values are different among the plant families, plant species and soil variations, rainfalls, temperature and other ecological conditions (Shadnoush, 2004; Shadnoush, 2013).

The nutritive value of forage can be determined by their digestibility, chemical composition, or a combination of chemical constituents and *in vitro* techniques of digestibility (Pinkerton, 1996; Akbarinia and Koocheki, 1992; Arzani *et al.*, 2004; Shadnoush, 2013). The aim of this study was to evaluate the nutritive value and seasonal variations of some range plant species of three families in semi- arid rangeland of Chaharmahal-Bakhtiari province in Iran.

Materials and Methods

Case study

The study was carried out in five different controlled stations of Shahrekord, Borujen, Farsan, Lordegan and Ardal located between 31°9' to 32°48' N and 49°30' to 51°26' W. These areas are accountes as a whole for the medium conditions rangeland in Chaharmahal and Bakhtiari province, Iran. The mean altitude of area is 2000m. The climate of this region is semi-arid with the annual mean temperature of 11.2°C and about 600 mm precipitation with peak rainfalls in fall and winter. Precipitation is also very erratic and distributed as 30, 52 and 18 percent in fall, winter and spring, respectively. However, 4 or 5 months of the year are dry (Reisian, 1998). These extreme year to year rain and moisture variations are probably greater constraints on the ecological and agricultural systems as compared to the low annual amount of rainfall. Droughts are also common and frequently severe.

Sampling method and analytical procedures

Forage species of *Vicia variabilis, Astragalus* spp., *Medicago sativa*, *Prangos uloptera* and *Sanguisorba minor* which belonged to Leguminosae, Umbelliferae and Rosaceae families were collected from the controlled station that were prohibited of grazing for ten years. Sampling was done three times at vegetative, blooming and seed ripening stages (May- Sep). As the ranges were hand harvested at 2-4 cm above ground level until the adequate amounts of material were obtained, species composite was specified in each sampling stage and area. Sampling was intended to simulate the grazing by sheep (Ghadaki *et al.*, 1974). Samples were air-dried and then, they were passed through a mill (1 mm) and stored in plastic containers for further analysis.

All samples were analyzed in the laboratories of Technology University in Isfahan. Dry Matter (DM) was determined by placing the air- dried samples at 105°C for 48 h. Crude Protein (CP) was analyzed by micro Kjeldahl procedure by Kejltec Auto analyzer 1030 (N×6.25), Ether Extract (EE) by Suksalate producer and used the di-ethyl ether solvent for 6 h and Crude Fiber (CF) by Fibertec system I and sulfuric acid. Gross Energy (GE) values were determined using a bomb calorimeter (Adiabatic bomb, Parr Instrument Company, Moline, IL, USA) and benzoic acid as a standard. Total ash was determined after incinerating the samples in a muffle oven at 550°C for 5 h (AOAC, 1990). Neutral Detergent Fiber (NDF) and Acid Detergent Fiber (ADF) were examined using the method proposed by Van Soest *et al.* (1991). Dry Matter Digestibility (DMD) and Organic Matter Digestibility (OMD) were determined using two in vitro stages of Tilly & Terry method (1963).

Statistical analysis

Data were statistically analyzed by GLM of SAS software (2001) using a factorial experiment based on completely randomized block design with four replications and two factors of forage species and three phenological stages. Means and standard error of traits were compared using Duncan Multiple Range Test (DMRT).

Results and Discussion

Species chemical composition, nutrient value, digestibility means and standard error of chemical compositions and digestibility of the studied range species are shown in Tables 1 and 2. The mean CP percent of species was 14.3 (ranged 108-18.5), mean EE percent was 3.7 (ranged 1.9-4.4), mean CF percent was 26.9 (ranged 24.2- 30.5), total mean Ash percent was 9.6 (ranged 8.7- 10.8) and mean GE was 4.1 Mcal kg^{-1}. There were significant differences among the species for some nutrients due to species genetic variation, dissimilarity of family and structural differences of plants. These results are in accordance with the suggestions of Arzani *et al.* (2004); Ganbari and Sahraei (2012); Shadnoush (2013) and Ventaura *et al.* (2004).

The mean NDF and ADF percent with those ranged in the studied species were 45.3 (49.4-40.1) and 32.5 (34.3-31.0), respectively. Means of DMD and OMD percent and those variations in the species were 53 (59.3-46.6) and 61 (66.7-56.5), respectively. There was a considerable variation between the samples for cell wall contents (NDF and

ADF) which represent the most important fraction of dry matter for all the species. These results are in agreement with previous reports (Arzani *et al.*, 1998; Ganbari and Sahraei, 2012; Shadnoush, 2013; Akbarinia and Koocheki, 1992).

Table 1. Means and standard error for chemical composition of studied range species

Family Name	Species Name	No.	CP%	EE%	Ash%	CF%	GE (Mcal kg^{-1} DM)
Leguminosae	*Vicia variabilis*	36	18.5 ±0.6 ^{a}	2.6±0.3 ^{c}	8.8 ± 0.2^{c}	27.0 ±1.0^{b}	4.1±0.08
Leguminosae	*Astragalus* spp.	41	15.0 ±0.5 ^{c}	1.9±0.2 ^{d}	7.9±0.3 ^{d}	27.1 ± 0.8 ^{b}	4.1±0.08
Leguminosae	*Medicago sativa*	45	16.9 ±0.5^{b}	2.9±0.2 ^{c}	9.8 ±0.3 ^{b}	30.5 ±0.9 ^{a}	4.2±0.07
Umbelliferae	*Prangos uloptera*	54	10.1 ±0.4 ^{d}	4.4±0.2 ^{a}	10.8 ±0.2 ^{a}	24.2 ± 0.7 ^{c}	4.0 ±0.06
Rosaceae	*Sanguisorba minor*	45	10.8 ±0.5^{d}	3.5±0.2 ^{b}	8.7± 0.3 ^{c}	25.7 ± 0.9 ^{bc}	4.0±0.07
Means ± SE	-	-	14.3 ±0.5	3.7±0.2	9.6 ± 0.2	26.9 ± 0.9	4.1±0.07

Means followed with different letters (a, b, c and d) in the same column of each species differ significantly ($P<0.05$)

Table 2. Means and standard error for some of nutrient value and digestibility of studied range species

Species Name	No.	NDF%	ADF%	DMD%	OMD%
Vicia variabilis	36	49.4 ±1.6 ^{a}	31±1.1.0 ^{b}	59.3 ± 2.2^{a}	61.7 ±2.4^{b}
Astragalus spp.	41	47.7 ±1.4 ^{ab}	34.3±1.0 ^{a}	51.5± 2.0 ^{b}	60.5 ± 2.2 ^{b}
Medicago sativa	45	46.0 ±1.3^{b}	33.8±0.9 ^{a}	49.3 ±1.8 ^{bc}	59.0 ±1.9 ^{bc}
Prangos uloptera	54	40.1 ±1.1 ^{d}	31.6±0.8 ^{b}	58.0 ±1.6 ^{a}	66.7 ± 1.7 ^{a}
Sanguisorba minor	45	43.4 ±1.3^{c}	32.5±0.9 ^{ab}	46.6 ± 1.8 ^{c}	56.5 ± 2.1 ^{c}
Means ± SE	-	45.3 ±1.3	32.5±0.94	53.0 ± 1.9	61.0 ± 2.0

Means followed with different letters (a, b, c and d) in the same column of each species differ significantly ($P<0.05$)

Crude protein

Means of CP content in phonological stages of the studied range species are shown in Table 3. Overall mean was 14.3 and means of vegetative, blooming and ripening stages were 18.9, 13.8 and 10.2%, respectively. Considering the plant species and phenological and sampling stages, the maximum value of CP was observed in the vegetative stage of *Medicago sativa* and minimum value was found in the ripening stage of *Prangos uloptera*. There was also a significant ($P<0.05$) variation among phenological stages of all the species for CP (Table 3). Thus, CP content was significantly ($P<0.05$) different between three phenological stages and range forage has a higher CP content at the early stage of growth than the later ones. Many factors such as growth stage (Promkot and Wanapat, 2004), maturity and species (Von Keyserlingk *et al.*, 1996) affect CP content. These results are in agreement with the suggestion of Jerry *et al.* (1989). Akbarinia and Koocheki (1992), Arzani *et al.* (1998) and Arzani *et al.* (2004) reported similar results. They reported seasonal changes in CP of range plant during different phenological stages and when plants became older, CP content was declined.

In this experiment, forage exhibited higher CP values in the vegetative stage; then, it slowly decreased in the blooming stage and showed the lowest content at the seed ripening stage. These phenological fluctuations in CP may have been induced by weather temperature, and variations of seasonal precipitations (Shadnoush, 2013). Variation of leaf to stem ratio and structural changes in the plants are important factors which affecte CP content of the plants in phenological stages and structural differences among the species (Arzani *et al.*, 2004; Jerry *et al.*, 1989 and Shadnoush, 2013). In addition, these results are in accordance with the reports of Ghoorchi (1995) indicating the reduction of CP of forage when plants matured. So, CP requirements for ewes suckling lambs (11.5% CP) should be supplied by the supplementation in some species after the vegetative stage, but ewe maintenance (8.9% CP) was adequate for sheep grazing on most accessions, especially in spring and early summer (Murray, 1964).

Table 3. Means and standard error of CP% between species and among phenological stages of studied range species

Species Name	No.	Vegetative	Blooming	Ripening	Means ± SE
Vicia variabilis	34	21.8 $^{a\,(A)}$	20.4 $^{b\,(A)}$	13.1 $^{c\,(A)}$	18.5± 0.56 $^{(A)}$
Astragalus spp.	40	22.1 $^{a\,(A)}$	13.9 $^{b\,(B)}$	10.1 $^{c\,(B)}$	15.4± 0.51 $^{(C)}$
Medicago sativa	45	23.0 $^{a\,(A)}$	15.3 $^{b\,(B)}$	12.7 $^{c\,(A)}$	16.9±0.50 $^{(B)}$
Prangos uloptera	54	13.7 $^{a\,(B)}$	9.4 $^{b\,(C)}$	6.9 $^{c\,(C)}$	10.0± 0.40 $^{(D)}$
Sanguisorba minor	43	14.3 $^{a\,(B)}$	10.0 $^{b\,(C)}$	8.0 $^{c\,(C)}$	10.8± 0.50 $^{(D)}$
Means ± SE	-	18.9± 0.85^{a}	13.8± 0.82^{b}	10.2±0.80^{c}	14.3 ± 0.50

Means with in species and a phenological stage in a row followed by different lowercase letter (a, b, c) are significantly different (P<0.05)

Means of species for each phenological stage in a column followed by different uppercase letter (A, B, C, D) in parenthesis are significantly different (P<0.05)

Crude fiber

Means of CF value in sampling stages of the studied range species are shown in Table 4. Overall mean was 26.9 and means of vegetative, blooming and ripening stages were 22, 28.7, and 30%, respectively. The minimum amount of CF was found in the vegetative stage of *Prangos uloptera* as 18.2% and the maximum was found in the ripening stage of *Medicago sativa* as 31.9% which was of significant (P<0.05) differences between two mentioned species. In general, variation of CF was significant (P<0.05) between the vegetative stage with blooming and ripening stages in all the species. Unlike the CP content, range forage exhibited a lower CF in the early stage of growth as compared to the later stages. It seems that CF contents such as lignin, celluloses and hemicelluloses in all species were influenced by climatic conditions. In such seasons when precipitation was higher (spring), CF content was invariably lower. On the other hand, CF in most species was increased during dry seasons of summer and autumn. This result was in accordance with the results reported by Ramirez *et al.* (2004).

Furthermore, *Prangos uloptera* had the lowest mean of CF but *Astragalus* spp. had the highest one which belongs to Umbelliferae and Leguminosae families, respectively. Accordance to this finding, Ghoorchi (1995) reported that CF was lower in the vegetative species of Umbelliferae family than Leguminosae species but no differences were observed between blooming stages of them. The CF was similar between the blooming and ripening stages of all the pecies, except *Prangos uloptera* (Table 4).

When the data were analyzed based on the effects of years, the results showed that CF content of range species could be influenced by climatic conditions. In addition, phenological stage can be highly affected by lignin and fiber contents in rang species. Therefore, fiber and lignin are increased with maturity of plants as immature stems and leaves contain fewer fibers than mature stems which are generally formed from parenchyma tissues. Although in growing and primary flowering stages, range species have a higher leaf to stem ratio, the structural portion and CF content are low in the plants, but it will be changed by increasing the structural proportion towards the maturation. Other researchers (Arzani *et al.*, 2004; Ramirez *et al.*, 2004 and Shadnoush, 2013) reported variations of CF concentration for different species during the phenological stages. They concluded that with the progress of plant growth when plants became older, CF content increases in the structural carbohydrate with the increased celluloses, hemicelluloses and lignin. In this study, the CF content was significantly (P<0.05) different between the species in accordance with the progress of plant growth.

Table 4. Means and standard error of CF% between species and among phenological stages of studied range species

Species Name	No	Vegetative	Blooming	Ripening	Means ± SE
Vicia variabilis	35	23.9$^{b\,(B)}$	28.9$^{a\,(A)}$	28.4^{a}	27.0 ± 1.8$^{(B)}$
Astragalus spp.	41	20.8$^{b\,(C)}$	29.2$^{a\,(A)}$	31.4^{a}	27.2± 1.6$^{(B)}$
Medicago sativa	44	28.1$^{b\,(A)}$	31.5$^{a\,(A)}$	31.9^{a}	30.5± 1.4$^{(A)}$
Prangos uloptera	54	18.2$^{c\,(C)}$	25.1$^{b\,(B)}$	28.9^{a}	24.1± 1.3$^{(B)}$
Sanguisorba minor	43	19.1$^{b\,(C)}$	28.7$^{a\,(A)}$	29.4^{a}	25.7± 1.4$^{(B)}$
Means ± SE	-	22.1± 1.5^{b}	28.71.5±^{a}	30.0± 1.5^{a}	26.9 ± 1.5

Means within species and a phenological stage in a row followed by different lowercase letter (a, b, c) are significantly different (P<0.05)
Means of species for each phenological stage in a column followed by different uppercase letter (A, B, C) in parenthesis are significantly different (P<0.05**)**

Cell wall content

The results of overall means and mean value of Neutral Detergent Fiber (NDF) and Acid Detergent Fiber (ADF) in the studied range species are presented in Table 5. Overall means of NDF and ADF were 45.3 and 33.5%, respectively. Mean NDF percent of vegetative, blooming and ripening stages was 37.6, 46.9, and 51.3, respectively and these values for ADF were 26.7, 35.7 and 38.8%, respectively. As it has been shown, NDF and ADF concentrations were significantly (P<0.05) different between the vegetative and blooming stages in all the species and amounts of these nutrients were lower in the vegetative stage. Table 5 showed that the maximum value of NDF was observed in the seed ripening stage of *Astragalus* spp. (54.5%), but the minimum amount was found in the vegetative stage of *Prangos uloptera*.

Highest and lowest percent of ADF was seen in the ripening stage of *Prangos uloptera* (40.6%) and vegetative stage of *Sanguisorba minor* (25.5%), respectively. Many factors may affect fibrous contents of NDF and ADF such as growth stage (Promkot and Wanapat, 2004), maturity and species (Agbagla-Dohnani *et al.*, 2001; Ghanbari and Sahraei, 2012). Considering the above information as plant growth progressed in all the species, NDF and ADF contents were increased (Table 5). In all species except *Vicia variabilis*, the NDF value was not significantly increased in the seed ripening stage as compared to blooming stage because physical structure of these species was fully developed in the blooming stage. During spring, NDF and ADF were lower than summer and autumn.

Although young plant cells have one external layer called primary cell wall, a secondary cell wall is formed when they become mature. Also, due to the increased structural carbohydrates in the blooming stage and storage tissue in the seed ripen one, ADF and NDF contents varied from the vegetative to blooming and seed ripening stages; however, it depends on the species. Similar results were reported for NDF and ADF in some Iranian range species (Arzani *et al.*, 1998, 2004; Shadnoush, 2013) when they found that by progress of plant growth, ratio of structural carbohydrates mostly consisted of celluloses, hemicelluloses and lignin is to be increased. Therefore, maturity of plant caused an increase in structural carbohydrates and higher ADF and NDF amounts in plant species (Shadnoush, 2013). Also, Scarborough *et al.* (2001) reported that sampling stage affected the concentrations of ADF and NDF in the un-grazed and grazed range species.

Table 5. Means and standard error of NDF and ADF% between species and phenological stages of studied range species

Nutrients%	Species Name	No	Vegetative	Blooming	Ripening	Means ± SE
NDF	*Vicia variabilis*	34	43.4 $^{c\,(A)}$	51.6 $^{b\,(A)}$	53.2 $^{a\,(AB)}$	49.4 ±2.7
	Astragalus spp.	41	41.1 $^{b\,(AB)}$	46.7 $^{a\,(A)}$	54.5 $^{a\,(A)}$	47.4 ±2.5
	Medicago sativa	43	38.0 $^{b\,(BC)}$	49.3 $^{a\,(A)}$	50.8 $^{a\,(AB)}$	46 .0±2.2
	Prangos uloptera	54	31.0 $^{c\,(C)}$	39.2 $^{b\,(B)}$	50.2 $^{a\,(AB)}$	40.1 ±2.0
	Sanguisorba minor	43	34.4 $^{b\,(C)}$	47.9 $^{a\,(A)}$	47.8 $^{a\,(B)}$	43.4 ±2.2
	Means ± SE	-	37.6 ±2.3 ^{b}	46.9 ±2.3 ^{a}	51.3 ±2.3 ^{a}	45.3±2.3
ADF	*Vicia variabilis*	34	27.9 ^{b}	40.8 $^{b\,(A)}$	34.4 $^{a\,(B)}$	34.4 ±1.8
	Astragalus spp.	41	26.4 ^{c}	36.3 $^{b\,(B)}$	40.1 $^{a\,(A)}$	34.3 ±1.6
	Medicago sativa	43	27.6 ^{b}	35.9 $^{a\,(B)}$	37.9 $^{a\,(A)}$	33.8 ±1.4
	Prangos uloptera	54	25.7 ^{c}	31.5 $^{b\,(C)}$	40.6 $^{a\,(A)}$	32.6 ±1.3
	Sanguisorba minor	43	25.5 ^{c}	33.8 $^{b\,(BC)}$	38.5 $^{a\,(A)}$	32.6 ±1.5
	Means ± SE	-	26.7 ±1.6 ^{c}	35.7± 1.5 ^{b}	38.3 ±1.5 ^{a}	33.5±1.5

Means with in species and a phenological stage in a row followed by different lowercase letter (a, b, c) are significantly different ($P<0.05$)
Means of species for each phenological stage in a column followed by different uppercase letter (A, B, C) in parenthesis are significantly different ($P<0.05$)

Digestibility

Means of dry matter digestibility (DMD) and organic matter digestibility (OMD) are shown in Table 6. The overall means of *in vitro* DMD and OMD of the studied range species were 54 and 62.3%, respectively. Means of DMD and OMD percent were 60.8, 67.9; 53.5, 61.9, 49.2 and 62.3%, respectively in the vegetative, blooming and ripening stages. The DMD and OMD percent was reduced significantly ($P<0.05$), passing vegetation in spring to the blooming stage in summer; then, it slightly declined in the seed ripening stage ($P>0.05$) in most species, except *Prangos uloptera*. In all the species, the highest values of DMD and OMD were seen in the vegetation stage of *Vicia variabilis* (65.9 and 71.9%, respectively) but the lowest value of DMD was observed in *Medicago sativa* (43.4%) whereas minimum percent of OMD was seen in *Sanguisorba minor* at the ripening stage. The variation in present study is in line with the report of Givens *et al.* (1990) indicating that DMD of the plants varied significantly according to the herbage variety and growth stage.

Daalkhaijav (2000) showed that their nutritive values generally decrease as the plant age is increased. The lower DMD seen in late period of range plant growth, especially seed ripening stage was related to higher NDF contents that is in accordance with the results of Arzani *et al.* (2004) and Shadnoush (2013) who reported that DMD was mainly decreased by the progress of growth in the range species. Before these reports, a reduction in DMD was observed with the maturity of plants due to the increase of structural tissues in stems (Akbarinia and Koocheki, 1992). They also stated that digestibility rate in DMD of range species is due to the amounts of digestible carbohydrates in seeds when seed became mature. Forage digestibility is negatively associated with acid detergent fiber concentration (Van Soest, 1994).

It is well accepted that forage digestibility in the rumen is mainly affected by the cell wall content and its lignifications. Lignin limits the access and potential performance of microbial enzymes to the structural polysaccharides of the cell wall. Ammar (2002) reported a negative and significant correlation in

NDF, ADF and lignin with digestibility. In addition, Pinkerton (1996) reported a close relationship between digestibility and cell wall contents in plants. He expressed that cell contents could be 100% digestible and this trait will not be reduced even when the plant becomes mature. In contrast, structural chemical composition of cell walls mainly changed with the plant growth. As plant growth continues, fiber contents are increased and digestibility is decreased.

Among all the studied range species, *Vicia variabilis* and *Sanguisorba minor* showed most changes of OMD in phenology stage but *Prangos uloptera* and *Medicago sativa* had the least variations. It may be credibility reason for *Vicia variabilis* and *Sanguisorba minor* considered as a good grazing plant by sheep and goats, especially in the vegetative stage. On contrary, *Prangos uloptera* and *Medicago sativa* had nearly constant OMD during summer and autumn; thus, they were not affected significantly in late growing period. These results were in line with the results reported by Shadnoush (2013) and Deinum *et al.* (1968). They found that as plant growth progressed, structural carbohydrates were developed, NDF and ADF increased so that OMD decreased from the vegetation to the blooming stages. In addition, they found that temperature and maturity have great impacts on digestibility and nutritive values of grasses. Ghadaki *et al.* (1974) reported the differences in digestibility between forage in arid-zone and temperate-zone that could be explained by the differences in the amounts of precipitation in this area.

Table 6. Means and standard error of DMD and OMD% among species and phenological stage of studied range species

Nutrients%	Species Name	No	Vegetative	Blooming	Ripening	Means ± SE
DMD	*Vicia variabilis*	35	65.9$^{a (A)}$	57.5$^{b (A)}$	54.6$^{b (A)}$	59.3±3.8$^{(A)}$
	Astragalus spp.	40	58.4$^{a (B)}$	50.9$^{b (AB)}$	47.5$^{b (B)}$	52.3±3.5$^{(B)}$
	Medicago sativa	44	56.2$^{a (B)}$	47.3$^{b (B)}$	43.4$^{b (B)}$	49.0±3.1$^{(B)}$
	Prangos uloptera	53	60.8$^{(AB)}$	58.6$^{(A)}$	54.8$^{(A)}$	58.1±2.8$^{(A)}$
	Sanguisorba minor	42	62.9$^{a (A)}$	53.2$^{b (AB)}$	45.7$^{b (B)}$	53.9±3.2$^{(AB)}$
	Means ± SE	-	60.8± 3.3^{a}	53.5± 3.3^{b}	49.2±3.2^{b}	54 ± 3.3
OMD	*Vicia variabilis*	35	71.9^{a}	63.2^{b}	57.6$^{b (AB)}$	64.2 ±4.1
	Astragalus spp.	40	65.1^{a}	60.9^{ab}	55.7$^{b (AB)}$	60.6±3.8
	Medicago sativa	44	67.0^{a}	61.5^{ab}	58.8$^{b (AB)}$	62.4 ±3.4
	Prangos uloptera	53	66.9^{a}	64.5^{ab}	60.7$^{b (A)}$	64.0±3.0
	Sanguisorba minor	42	68.7^{a}	59.6^{b}	53.4$^{b (B)}$	60.8 ±3.4
	Means ± SE	-	67.9±3.6^{a}	61.9±3.5^{ab}	57.2±3.5^{b}	62.3±3.6

Means with in species and a phenological stage in a row followed by different lowercase letter (a, b, c) are significantly different (P<0.05)
Means of species for each phenological stage in a column followed by different uppercase letter (A, B) in parenthesis are significantly different (P<0.05)

Conclusions

In all species, nutrient quality of CP was seriously affected by the phenological stages. Higher level of this important nutrient was observed in spring and vegetative stage. The same pattern occurred for DMD and OMD. Conversely, structural fibrous contents were lower in the vegetative and blooming stages. There were some differences between species in level of CP, fibrous contents and their digestibility. Amounts of CP content were insufficient to meet nutrient requirements of range goats and sheep after the blooming stage and with most species so that supplementation is needed. The native species of *Vicia variabilis*, *Astragalus* spp. and *Medicago sativa* can be considered as valuable species for goats and sheep because of their relatively high CP, DMD and OMD contents. Consequently, one of the objectives of the related researches for improving the species for sheep and goats in semi-arid regions should be to develop the species with high essential available nutrients like CP, DMD and OMD contents.

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تغییرات فصلی مواد مغذی و قابلیت هضم برخی از گیاهان مرتعی استان چهارمحال و بختیاری

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چکیده. از گونه‌های مرتعی ***Vicia variabilis*، Astragalus spp.، *Medicago sativa*، *Prangos uloptera*** و ***Sanguisorba minor*** در مراحل سه گانه فنولوژی، اقلیم‌های مختلف و مناطق قرق در استان چهارمحال و بختیاری نمونه گیری گردید. نمونه‌ها برای تعیین پروتئین خام، عصاره عاری از اتر، فیبرخام، خاکستر، فیبر نامحلول در محلول خنثی و اسید، قابلیت هضم آزمایشگاهی ماده خشک و ماده آلی مورد استفاده قرار گرفتند. بیشترین میزان پروتئین خام با ۲۳ درصد در مرحله رویشی ***Medicago sativa*** و کمترین آن ۶/۹ درصد در مرحله بذردهی ***Prangos uloptera*** دیده شد. کمترین درصد فیبرخام در مرحله رویشی ***Prangos uloptera*** و بیشترین آن در مرحله بذردهی ***Medicago sativa*** دیده شد. حداقل فیبر نامحلول در شوینده خنثی و اسیدی به ترتیب در مراحل رویشی گونه‌های ***Prangos uloptera*** و ***Agropyron intermedium*** و ***Sanguisorba minor*** بود، اما بیشترین این مقادیر در مراحل بذردهی ***Astragalus* spp.** و ***Prangos uloptera*** دیده شد. بیشترین و کمترین مقدار قابلیت هضم ماده خشک و ماده آلی در مرحله رویشی ***Vicia variabilis***، اما کمترین این مقادیر به ترتیب در گونه‌های ***Medicago sativa*** و ***Sanguisorba minor*** دیده شد. درصد قابلیت هضم ماده خشک و ماده آلی با ادامه رشد گیاه از مرحله رویشی به بذر دهی در تمام گونه‌ها کاهش یافت. به طورکلی می توان گفت که در هنگام تعیین جیره غذایی دام‌ها از مرتع در نظر گرفتن تغییرات فصلی مواد مغذی و قابلیت هضم گیاهان مرتعی ضروری می باشد. در انتهای فصل رشد گیاهان برای تأمین احتیاجات ضروری دام‌های مرتعی استفاده از مکمل‌های انرژی و پروتئین توصیه می‌شود.

کلمات کلیدی: تغییرات فصلی، گیاهان مرتعی، مواد مغذی، قابلیت هضم، ایران