SHORT COMMUNICATION

Chemical composition and forage yield of three Vicia varieties (Vicia spp.) at full blooming stage

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Abstract

Mixing nitrogen-stabilizing leguminous forages such as Vicia spp. with livestock feeding systems like farm-pasture or farm-animal systems is one of the best approaches to reserve seasonal feeds, to decrease the load on pasture, and to increase soil fertility. The objective of this study was to determine the chemical compositions and fresh/dry forage yield of three varieties of Vicia spp. (Vicia narbonensis, narbon vetch, accession 2561; Vicia sativa, common vetch, accession 463; Vicia dasycarpa, woolly-pod vetch, accession 2446) at full blooming stage. The plants were grown under the climatic conditions of the province of Lorestan in Western Iran and were harvested at full blooming stage. Fresh and dry forage yields, as well as protein yield, were significantly higher (P<0.05) in narbon vetch (28847, 7366 and 1400 kg per hectare, respectively) than in woolly-pod (24825, 4884 and 1050 kg per hectare, respectively) and common vetch (20727, 6601 and 564 kg per hectare, respectively). Woolly-pod vetch had the highest content of crude protein (21.5%) and ash (12.3%), while common vetch had the highest content of neutral detergent fibre (43.9%). There was no difference in degraded dry matter (DDM) between the Vicia varieties in vitro. Results showed that all the Vicia varieties provide high quality forage for livestock, and can be recommended for cultivation because of their adaptability to the particular conditions of a region.

Introduction

The genus Vicia is made up of approximately 190 species worldwide. The genus is primarily found in the Mediterranean and Irano-Turanian regions. However, the genus Vicia is widely distributed in the temperate zone of the northern hemisphere and in extra-tropical South America. There are approximately 47 species of vetches in Iran. Most of the vetches that grow in this region are wild species and are normally grown under rainfed conditions. These plants, such as V. narbonensis (narbon vetch), V. sativa subsp. sativa (common vetch), and V. villosa subsp. dasycarpa (woolly-pod vetch) are grown in both humid and semi-dry areas as livestock feeds (Larbi et al., 2010b). Common vetch (Vicia sativa ssp. sativa L.) is a multi-purpose, cool season, annual legume grown for livestock feed and to improve soil fertility in Mediterranean environments where average annual rainfall ranges from 250 to 350 mm (Larbi et al., 2011a). Woolly-pod vetch (Vicia villosa ssp. dasycarpa), a cool season legume, is grown for pasture, hay, silage, and grain for livestock feed, as well as green manure and cover crop for weed control and to improve soil productivity (Larbi et al., 2011b). It tolerates cold better than bitter vetch (V. ervilia), narbon vetch (V. narbonensis), or common vetch (V. Sativa) (Larbi et al., 2011b). Narbon vetch (Vicia narbonensis L.) is a cool-season, drought-tolerant, annual legume, with greater potential for grain production as a livestock feed in non-tropical dry areas than common vetch (Vicia sativa), bitter vetch (Vicia ervilia), or woolly-pod vetch (Vicia villosa subsp. dasycarpa) (Larbi et al., 2010a). Vetches can either be grazed as fresh forage (Haddad, 2006) or can be cut and preserved as hay or silage (Abdullah et al., 2010). Hay of vetches can be used as a protein supplement, while their grains serve as protein and energy sources in rations of ruminants and non-ruminants (Sadeghi et al., 2009). However, there is little information available on the forage yield or chemical composition of vetches grown under climatic conditions of Iran. Therefore, the current study aimed to determine forage fresh and dry yields and chemical composition of three species of genus Vicia including Vicia narbonensis, (narbon vetch, accession 2561), Vicia sativa (common vetch, accession 463), and Vicia dasycarpa (woolly-pod vetch, accession 2446) at full blooming stage.

Materials and methods

Sites, experimental design and management

Three varieties of Vicia spp (Vicia narbonensis, narbon vetch, accession 2561; Vicia sativa, common vetch, accession 463; Vicia dasycarpa, woolly-pod vetch, accession 2446) were evaluated for their chemical composition and fresh/dry forage yield using a randomised complete block design with three replicates. The experiment was conducted at the research farm of Natural Resources and Animal Science Research Institute of Lorestan in Khorramabad, Lorestan, Iran (33°29’16”N, 48°21’21”E) where the long-term average rainfall is 520 mm. Varieties were sown on 13 July 2010, at a seeding rate of 230 seeds per m², at a seeding rate of 230 seeds per m², with row spacing of 30 cm, and with a plant density of 100 plants per m². The plots were manually clipped at ground level using a small scythe. The products from each plot were weighed separately to determine fresh yields of each variety (kg/ha). To determine dry yield, the fresh samples were oven-dried at 38°C for 72 h.

Chemical analyses

Samples of each variety were ground to pass
a 1 mm screen, and analysed for dry matter (DM), ash, and crude protein (CP) according to the AOAC method (1990). Neutral detergent fibre (NDF) and acid detergent fibre (ADF) were determined according to methods described by Van Soest et al. (1991).

To determine in vitro DM degradability, in two consecutive runs, three replicates of each substrate were fermented in specific 150-mL syringes containing 0.2 g DM of each substrate, 22.5 mL of phosphate-bicarbonate buffer and 7.5 mL of rumen fluid inoculum. The inoculum was a mixture of rumen fluid obtained over 96 h from three non-lactating Taleshi cows. The amount of degraded dry matter (DDM), after 96 h incubation, was calculated as the difference between incubated and residual DM. The latter was determined by filtering the contents of the syringes through filter papers (Whatman #54) and drying at 104°C for 4 h. For all chemical analyses, samples were analysed in duplicate and repeated if the error was higher than 5%.

**Statistical analysis**

Statistical analyses were carried out using the MIXED procedure of SAS version 9.2 (2003). The model used was:

\[ Y_{ijk} = \mu + B_i + V_j + e_{ijk} \]

where, \( Y_{ijk} \) is the dependent variable under examination, \( \mu \) is the population mean for the variable, \( B_i \) is the random effect of experimental plots \((i=3; 1, 2, 3)\), \( V_j \) is the fixed effect of variety \((j=3; \text{Vicia narbonensis}, \text{Vicia sativa} \text{ and Vicia dasycarpa}) \) and \( e_{ijk} \) is the random error associated with the observation \( ij \). P<0.05 was considered significant. Fisher’s protected least significant difference (LSD) test was used for multiple treatment comparisons using the LSMEANS of SAS version 9.2 (2003) with letter grouping obtained using SAS pdmix800 macro. The residual analysis was carried out to test the model assumptions using the UNIVARIATE procedure of SAS ver. 9.2 (2003) with NORMAL and PLOT options.

### Results and discussion

Narbon vetch had the highest fresh and dry forage yields with averages of 28,847 and 7366 kg/ha, respectively (Table 1; P<0.05). This can be partly explained by the fact that narbon vetch adapts better to cold and dry weather compared to woolly-pod and common vetch. Woolly-pod vetch had the highest CP content (Table 2; P<0.05); however, the yield of crude protein yield was significantly higher (P<0.05) in narbon vetch than in common and woolly-pod vetch (Table 1). This was mainly due to higher DM yield of narbon vetch compared to common and woolly-pod vetch (Table 1).

There were significant differences in CP, ash and NDF content among the *Vicia* varieties (Table 2). Woolly-pod and common vetch had the highest and the lowest CP content (Table 2; P<0.05). Significant differences were observed in ash content of narbon and woolly-pod vetch compared to common vetch (12.3 and 10.3 vs 8% of DM; P<0.05). NDF content in vetches varied from 34.2 to 43.9% and there were significant differences in NDF content between common vetch and narbon vetch (P<0.05; Table 2). Common vetch and narbon vetch contained the highest and the lowest NDF content, respectively (Table 2). No significant difference was found in ADF and degraded DM among the *Vicia* varieties (Table 2).

The differences found in the chemical compositions of vetches may be attributed to several factors such as leaf-to-stem ratio, chemical constituents available in seed, adaptability to cultivation lands and resistance to environmental stress. Larbi et al. (2010b) suggested that difference in forage quality might be due to the seasonal differences among species in terms of compactness and lignification of cell walls and leaf-to-stem ratio. Forage quality is affected by interaction between species and stage of growth. They also reported differences in terms of forage quality among various species grown in the same environment and with the same growth stage. Leaf-to-stem ratio had a great impact on quality of forage. The higher this ratio, the higher the quality of forage in terms of protein content (Mazaheri Laghab, 2008).

In our study, narbon vetch had the highest fresh and dry forage yields and protein yield. Ayed et al. (2001) also showed that narbon vetch had the highest dry matter yields among the species studied. Narbon vetch adapts to stresses resulting from dry condition better than the other vetches. Therefore, it has the potential to produce more fresh and dry forage in arid and semi-arid areas compared to the other legumes. In stressed environmental conditions, this plant produced more than 1.8 ton/ha seed and 4.5 ton/ha fresh forage. In experiments conducted by ICARDA, it was shown that at pod maturity stage, narbon vetch had the highest dry matter yields, while common vetch was more palatable than narbon vetch (Abd-El-Moneim and Zhibianonn, 2002).

A comparison between varieties showed no significant difference in DDM, but narbon vetch had a numerically higher DDM compared to common vetch and woolly-pod vetch. This was due to lower ADF and NDF content in narbon vetch compared to the other vetches. Our findings were in agreement with those reported by Buxton and Fales (1991) and Karabulut et al. (2006) who found that ADF has a negative correlation to the digestibility of forages. Larbi et al. (2010) also found a negative corre-

| Table 1. Protein, fresh and dry yields of three *Vicia* varieties at full blooming stage. |
|-----------------------------------------------|
| Variety | Fresh, kg/ha | Dry, kg/ha | Protein, kg/ha |
|---------|--------------|------------|----------------|
| Common vetch | 20727abc | 6061abc | 564abc |
| Woolly-pod vetch | 24825c | 4884c | 1050c |
| Narbon vetch | 26847a | 7366a | 1400a |
| SEM | 879.6 | 300.3 | 60.8 |

*Means with different letters in the same column are significantly different (P<0.05). Multi-treatment comparison method is Fisher’s Protected LSD.*

| Table 2. Chemical composition and degraded dry matter of three *Vicia* varieties at full blooming stage. |
|-----------------------------------------------|
| Variety | CP %DM | Ash %DM | ADF %DM | NDF %DM | DDM g/kg |
|---------|--------|--------|--------|--------|---------|
| Common vetch | 9.3a | 8a | 35.8 | 43.9a | 487 |
| Woolly-pod vetch | 21.5a | 12.3a | 32.3 | 38b | 542 |
| Narbon vetch | 19a | 10.9a | 28.8 | 34.2a | 553 |
| SEM | 0.3 | 0.6 | 2.0 | 1.9 | 15.9 |

*Means with different letters in the same column are significantly different (P<0.05). Multi-treatment comparison method is Fisher’s Protected LSD.*

CP: crude protein; ADF: acid detergent fibre; NDF: neutral detergent fibre; DDM: degraded dry matter in vitro.
lation between ADF and in vitro organic matter (OM) digestibility in vetches. In the initial stages of growth, all parts of the plant are highly digestible. However, during the flowering period and stem growth, there is a rapid decrease in stem digestibility compared to that of leaves due to lignification. The reduced digestibility of the plant as growth progresses can also be attributed to factors such as increased fibre content in plant tissue, increased lignification, and increased leaf-to-stem ratio (Karabulut et al., 2006).

Conclusions

Our findings show that different varieties of vetch can be cultivated as fodder in different regions with reasonable fresh and dry forage yields to meet the requirements of livestock. Narbon vetch was superior in terms of fresh and dry forage yields as well as protein yield. However, more comprehensive studies and additional experiments are required to examine the nutritive values of such varieties at different growing stages and locations.

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