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EFFECT OF MATURITY STAGES ON POTENTIAL NUTRITIVE VALUE OF VICIA CRACCA (L.) HAY

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Abstract
The aim of the current experiment was to determine the effect of harvesting stage on the potential nutritive value. Vicia cracca plant was harvested at three maturity stages (before flowering, flowering and seeding). Vicia cracca plants were dried at 70 °C and grinded in a hand-mill with 1 mm sieve for chemical analysis. Crude protein, crude oil, crude ash, condensed tannin, acid detergent fiber (ADF), and neutral detergent fiber (NDF) parameters were investigated as the chemical composition. Harvesting stage had a significant ($p \leq 0.01$) effect on chemical composition.
Dry matter, NDF and ADF contents were increased with advancing maturity whereas crude protein, crude oil, condensed tannin and crude ash contents were decreased. As a conclusion, the nutritive value of Vicia cracca plant decreased with increasing maturity. Vicia cracca hays harvested at three maturity stages were adequate in term of mineral content for ruminant. Therefore, the Vicia cracca plant can be harvested or grazed before flowering and flowering stages due to high crude protein, crude oil and low ADF and NDF.

Keywords: Chemical composition, harvest time, mineral content, Vicia cracca.

1. INTRODUCTION

Forage legumes are used for livestock grazing, for dry hays and silage yields and most of the time used in feed rations because of high protein, energy, mineral and vitamin content (Berhane and Eik, 2006). *Vicia* spp. has about 160 annual and perennial species widespread throughout various climate zones all world (Maxted, 1995). The prominent annual species are bitter vetch, narbon vetch, common vetch, hairy vetch and all these species are commonly grown to feed livestock in regions (Larbi et al., 2011). *Vicia cracca* is a perennial plant grow up to a length of 200 cm and is widely distributed the natural pasture of Turkey (Karakurt, 2013). *Vicia cracca* one of the most common fodder plants in northern China and ıt is a wild high-quality forage widely used for mostly for silage, dry hay, green forage and grain (Wang et al., 2008).
There are many factors that affect the quality values of feeds. One of the most important of these is harvest time (Kaplan et al., 2016). Although the nutritive value of many types of legumes forages in the pasture harvested at different maturity stage is established, *Vicia cracca* hay isn't the information about the nutritive value. Recently a lot of researchers commonly used chemical composition (crude protein, crude oil, crude ash ADF, NDF, condense tannin) and mineral content

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to determine the potential nutritive value of different hays (Cacan et al., 2017; Kaplan et al., 2016; Cacan et al., 2017; Kamalak and Durmaz, 2019).
The current study was conducted to study the effect of maturity stage on the potential nutritive value of *Vicia cracca* hay.

2. MATERIALS AND METHODS

Plant material

Vicia cracca (L.) plants were manually harvested at three maturity stages (pre-flowering, flowering and seeding stages) from three plots that were established over the natural pastures of in Kayseri in Turkey in completely randomized block design (5x2 m) in the experimental field in 2020.

Chemical composition

Vicia cracca hays were dried in an oven at 70 ºC at 48 hours. Dried *Vicia cracca* hays were grinded in a hand mill with 1 mm screen and ready for chemical analyses. Crude ash analyses of *Vicia cracca* hays were performed through ashing them at 550 ºC for 8 hours in an ash oven (AOAC, 1990). Nitrogen (N) content was determined by Kjeldahl method and crude protein ratio was calculated by using the formula of N × 6.25 (AOAC, 1990). Fiber analysis (ADF and NDF) was done using the ANKOM Tech methods (Ankom, 2017). Condensed tannin content of the *Vicia cracca* hays was performed by using Bütanol-HCl technique (Makkar et al., 1995).

Mineral content

Vicia cracca hay samples were passed through wet-ashing process with hydrogen peroxide (2:3) in 3 different steps (1st step: at 145 ºC 75% microwave power for 5 minutes, 2nd step: at 80 ºC 90% microwave power for 10 minutes and 3rd step: at 100 ºC 40% microwave power for 10 minutes) in a wet-ashing unit (speed wave MWS-2 Berghof products + Instruments Harresstr.1. 72800 Enien Germany) resistant to 40 bar pressures (Mertens, 2005a). Then Ca, K, Mg, Na, P, S, Cu, Fe, Zn and Mn contents were determined by using ICP OES spectrometer (Inductively Couple Plasma spectrophotometer) (Perkin-Elmer, Optima 2100 DV, ICP/OES, Shelton, CT 06484-4794, USA) (Mertens, 2005b).

Statistical Analysis

SAS (SAS Inst. 1999) software was used to perform variance analysis on all experimental data accordance with randomized completed design experimental design with three replicates. LSD test was used to test the significance of differences among the means.

3. RESULTS AND DISCUSSIONS

Chemical composition of *Vicia cracca* hays were provided in Table 1. The effects of *Vicia cracca* hays, harvest time on chemical composition were found to be highly significant ($p<0.01$). The dry matter, ADF and NDF contents of hay increased whereas crude protein, crude ash, crude oil and condense tannin contents were decreased with increment of maturity stage. The dry matter, ADF and NDF contents varied between 15.41-22.14%, 26.90-39.09% and 39.74-46.49% respectively. Crude oil, crude protein, crude ash and condensed tannin contents varied between 1.62-2.97%, 14.11-19.50%, 6.12-8.74% and 1.16-1.48% respectively.
The marked decrease in crude protein, crude oil, crude ash and condense tannin and increase in dry matter, ADF and NDF with advancing maturity stage was in accordance with the findings of Kaplan et al. (2016) in teff hay, Kamalak and Durmaz (2019) in *Bituminaria bituminosa* hay, Ceylan and Kamalak (2019) in *Onopordum acanthium* hay, Atalay and Kamalak (2019) in *Chenopodium album*

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hay, Kurt and Kamalak (2020) in *Silybum marianum* hay, Akbay et al. (2020) in *Trigonella foenum-graecum* hay.

Table 1. The effect of maturity stage on the chemical composition of Vicia cracca hays

Nutrients (%)	Maturity Stages			LSD	Significance
	Before flowering	Flowering	Seeding		
Dry Matter	15.41^{c}	17.65^{b}	22.14^{a}	1.55	**
Crude oil	2.97^{a}	2.62^{b}	1.62^{c}	0.24	**
Crude protein	19.50^{a}	16.46^{b}	14.11^{c}	2.04	**
Crude ash	8.74^{a}	7.68^{b}	6.12^{c}	0.48	**
ADF	26.90^{c}	33.11^{b}	39.09^{a}	1.32	**
NDF	39.74^{c}	42.95^{b}	46.49^{a}	0.77	**
Condensed tannin	1.48^{a}	1.29^{b}	1.16^{c}	0.12	**

*** p<0.01; LSD: Least Significant Difference*

Decline in protein ratios with progression of ripening is generally related to both decreasing protein ratios in leaves and shoots and increasing ratio of shoots with low protein levels to entire plant and conversion of proteins into structural members (Kamalak et al., 2005). The crude protein content of stem is lower than that of leaves (Buxton, 1996). ADF and NDF contents are significant quality indicators of forage crops (Aydin et al., 2010) and such content should be low in quality forage since they inhibit the digestibility and consequently decrease the quality of forage. ADF and NDF ratios increase with the progression of maturity (Kamalak et al., 2005). It was reported for different forage crops species that increased ADF and NDF content reduced crude protein, crude oil, crude ash and condense tannin of the forage crops with the progress of maturity stage (Kaplan et al., 2014; Kaplan et al., 2016). Barry (1987) was reported that low condensed tannin levels (2-3%) had beneficial effects and condensed tannin prevent extreme decomposition of proteins in rumen. But high tannin level (5%) may result in the increased indigested crude protein due to excessive formation of tannin and protein complexes. In this study, condensed tannin levels (1.16-1.48%) were lower than those reported and so such levels had beneficial effects. Crude ash is accepted as an indicator of the minerals content of the plants and since minerals aren't possible to synthesize in animal body, they must be supplied externally (Gençtan, 1998). Plant oil contents are not constant and vary with the maturity stage, plant genetics, cultural practices and ecological conditions (Baydar, 2000). Kaplan et al. (2014) reported that the crude oil contents were decreased with increasing maturity.

The effect of maturity stage on the mineral contents of *Vicia cracca* are provided in Table 2. The maturity stage had significant effect on the mineral contents of hay ($p<0.01$). The K, Mg, P, S, Cu, Fe and Mn contents of *Vicia cracca* hay harvested at pre-flowering stage were significantly higher than harvested at flowering and seeding stages. The highest Ca, Na and Zn were observed in the flowering stage with 9375.76 ppm, 664.24 ppm and 42.08 ppm respectively.

The daily Ca, P, Mg and K requirements for maintenance varies between 0.20-0.82%, 0.16-0.38%, 0.12-0.18% and 0.50-0.80% of DM respectively for ewes that weight about 50 kg (NRC, 2001). There isn't serious risk for livestock when the Ca:P ratio is not exceeding 10:1 (Khan et al., 2007). Findings of current study were within these limits.

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The daily Fe, Cu, Mn and Zn requirements for maintenance varies between 30-50, 7-11, 20-40 and 20-33 mg/kg of DM respectively for ewes that weight about 50 kg (NRC, 2001). *Vicia cracca* hays harvested at three maturity stage was adequate in terms of Fe, Mn and Zn. (Table 2).

Table 2. The effect of maturity stage on the mineral content of Vicia cracca hays

Minerals (ppm)	Maturity Stages			LSD	Significance
	Before flowering	Flowering	Seeding		
Ca	7563.18^{b}	9375.76^{a}	5418.32^{c}	246.62	**
K	11717.10^{a}	9632.74^{b}	5785.80^{c}	468.74	**
Mg	1214.59^{a}	1085.09^{b}	934.79^{c}	126.78	**
Na	467.34^{b}	664.24^{a}	500.15^{b}	59.98	**
P	3183.79^{a}	2167.91^{b}	1931.49^{b}	250.96	**
S	2401.01^{a}	1283.89^{b}	1654.50^{b}	503.88	**
Cu	7.88^{a}	5.08^{b}	5.98^{b}	1.74	**
Fe	188.23^{a}	167.01^{b}	157.11^{b}	12.181	**
Zn	36.35^{b}	42.08^{a}	36.06^{b}	4.43	**
Mn	45.40^{a}	31.34^{b}	31.10^{b}	2.05	**

*** p<0.01; LSD: Least Significant Difference*

4. CONCLUSIONS

In conclusion, maturity stage had a significant effect on the nutritive value of the hay of *Vicia cracca*. The nutritive value of *Vicia cracca* hay decreased with increased maturity stage. It was concluded in that mineral contents of *Vicia cracca* hay harvested different maturity stage were found to be sufficient to meet the nutrient needs of ruminants and there was no need for additional minerals. So *Vicia cracca* (L.) plant can be harvested or grazed before flowering and after flowering stages due to high crude protein, crude oil and low ADF and NDF.

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