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N. TUĞBA BİNGÖL

M. AKİF KARSLI

İ. HAKKI YILMAZ

DURAN BOLAT

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Research Article

The Effects of Planting Time and Combination on the Nutrient Composition and Digestible Dry Matter Yield of Four Mixtures of Vetch Varieties Intercropped with Barley

N. Tuğba BİNGÖL[1,*], M. Akif KARSLI[1], İ. Hakkı YILMAZ[2], Duran BOLAT[1]

[1]Department of Animal Nutrition and Nutritional Diseases, Faculty of Veterinary Medicine, Yüzüncü Yıl University, 65080, Van - TURKEY

[2]Department of Agronomy, Faculty of Agriculture, Yüzüncü Yıl University, 65080, Van - TURKEY

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Abstract: The aim of this study was to determine the chemical composition, digestibility, energy content, and digestible dry matter yield of 4 mixtures of different vetch varieties intercropped with the same barley at 3 different planting times under Eastern Anatolian conditions. Four different vetch species, i.e. common (Farukbey-2001), Hungarian (Tarım Beyazı-98), hairy (Selçuklu-2002), and wooly pod (Segmen-2002), intercropped with barley (Tokak-157) were utilized. The mixtures of vetches intercropped with barley were planted on 7 October 2003 (I), 7 November 2003 (II), and 10 April 2004 (III), and each variety/planting time was randomly assigned to 3 replications. The mixtures of vetches intercropped with barley were harvested by hand using clippers when the barley started spiking and vetches were at 1/4 flowering. All samples were analyzed for dry matter (DM), ash, crude protein (CP), neutral detergent fiber (NDF), and acid detergent fiber (ADF) content. In vitro dry matter digestibility (IVDMD) of the samples was also determined. While DM and organic matter (OM) content did not differ, CP, NDF, and ADF content were significantly different among the different mixtures of vetch intercropped with barley ($P < 0.05$). IVDMD, metabolizable energy (ME), and net energy lactation (NEL) values were also significantly different among the mixtures of vetch intercropped with barley ($P < 0.05$). Digestible DM and ME yield of the mixtures were significantly affected by planting time ($P < 0.05$), but not variety. However, CP yield of the vetch-barley mixtures was significantly affected by both planting time and variety ($P < 0.05$). It can be concluded that all of the mixtures of vetch intercropped with barley had significantly higher digestible DM and CP yield when planted on 7 October 2003. Thus, October should be preferred for planting of the mixtures of vetch intercropped with barley in Eastern Anatolia. If a greater CP yield in addition to digestible DM yield is desired from vetch-barley hay, then common vetch should not be the choice.

Key Words: Vetch-barley mixtures, nutrient composition, digestibility, digestible DM yields

Arpayla Birlikte Ekilen Dört Fiğ Çeşidinin Ekim Zamanlarının Besin Madde Kompozisyonu ve Sindirilebilir Kuru Madde Verimi Üzerine Etkileri

Özet: Bu çalışma, Doğu Anadolu şartlarında 3 farklı ekim zamanında arpa ile birlikte ekilen 4 farklı fiğ varyetesinin kimyasal kompozisyonunu (besin madde içerikleri), sindirilebilirliğini, enerji içeriğini ve sindirilebilir kuru madde verimini belirlemek amacıyla yapıldı. Arpayla ekilen dört farklı fiğ çeşidi olarak, adi fiğ (Farukbey-2001), Macar fiği (Tarım Beyazı-98), tüylü fiğ (Selçuklu-2002) ve tüylü meyveli fiğ (Segmen-2002) çeşidi kullanıldı. Fiğ parselleri 7 Ekim 2003 (I), 7 Kasım 2003 (II), 10 Nisan 2004 (III) tarihlerinde ekildi ve her bir varyete/ekim zamanı rasgele 3 tekerrür olarak dağıtıldı. Fiğlerin 1/4'ünün çiçeklenmeye başlamasıyla ve aynı zamanda arpa başaklarının görülmesiyle bahçe makası kullanılarak elle hasat edildi. Bütün örneklerin kuru madde (KM), ham kül (HK), ham protein (HP), nötral deterjan lif (NDF) ve asit deterjan lif (ADF) düzeyleri analiz edildi. Örneklerin in vitro kuru madde sindirilebilirlikleri de (IVKMS) belirlendi. Fiğ varyeteleri arasında KM ve organik madde (OM) düzeylerinde farklılık görülmezken, HP, NDF ve ADF düzeyleri önemli derecede farklı bulundu ($P < 0,05$). İn vitro KM sindirilebilirlikleri, metabolik enerji (ME) ve net enerji laktasyon (NEL) değerleri de fiğ varyeteleri arasında önemli derecede farklı tespit edildi ($P < 0,05$). Sindirilebilir KM ve ME verimi ekim zamanından önemli derecede etkilenirken ($P < 0,05$) varyeteden etkilenmedi. Bununla birlikte fiğ-arpa karışımlarının HP verimleri ekim zamanı ve varyeteden önemli derecede ($P < 0,05$) etkilendi. Bu da bütün fiğ-arpa karışımlarının 7 Ekim 2003 tarihinde ekildiğinde sindirilebilir KM ve HP verimlerinin önemli derecede ($P < 0,05$) etkilendiği sonucunu gösterdi. Bu nedenle, Doğu Anadolu'da fiğ-arpa karışımlarının ekimi için Ekim ayı tercih edilmelidir. Sindirilebilir KM verimine ilaveten daha fazla HP verimi istendiği zaman adi fiğ tercih edilmemelidir.

Anahtar Sözcükler: Fiğ-arpa karışımı, besin madde kompozisyonu, sindirilebilirlik, sindirilebilir KM verimi

*E-mail: tnbingol1@hotmail.com

Introduction

Feed costs comprise 50%-70% of total farming expenses in Turkey (1). In order to reduce feed costs and create more sustainable management systems for moderately sized family operations, value-promoted livestock enterprises must be integrated with existing cropping enterprises.

One of the most important factors affecting the Turkish farming system is the lack of cheap, abundant, high quality feedstuff. The feeding of low-quality forages, such as crop residues (wheat, barley, straw) and low-quality hays, with protein (meal) or energy supplementation (grain barley) to wintering ruminants is a common practice in Turkey. However, these low-quality forages may limit the performance of dairy and fast growing beef cows due to their high gut-filling capacity (2). Dairy cows can only produce high milk yields and beef cows can only reach their maximum potential if their intermediary metabolism is supplied with sufficient nutrients (1). Thus, high-quality forages have to be produced.

Vetch is widely used in the Middle East for forage production in a mixed cropping system with oats (3) or barley (4). The inclusion of winter legumes, e.g., vetch, with winter cereals, such as barley, has the potential to improve the quality of forage (5). Crop mixtures may have clear advantages and superiority to monocultures, providing greater yield and quality, and more efficient use of all the resources available through enhanced crop plasticity (6). Mixtures can provide an alternative source of feed for animals during winter and early spring, when the hay supply is insufficient.

The objectives of this study were to determine the chemical composition, digestibility, energy content, and digestible dry matter (DDM) yield of the 4 mixtures of different vetch species intercropped with the same barley, which were planted at 3 different times in Eastern Anatolian conditions.

Materials and Methods

Four different vetch species, i.e. common (Farukbey-2001), Hungarian (Tarım Beyazı-98), hairy (Selçuklu-2002) and wooly pod (Segmen-2002), were selected. All of the vetches were planted with barley (Tokak-157) at rate of 140 kg/ha (ratio of 70% vetch to 30% barley). The mixtures of vetch intercropped with barley were planted on 7 October 2003 (I), 7 November 2003 (II), and 10 April 2004 (III), and each treatment was randomly assigned to 3 replications. The vetch-barley fields were fertilized with 150 kg of diammonium phosphate per hectare.

Vetches were harvested by hand using clippers when the barley started spiking and vetches were at 1/4 flowering. Then, all of the samples were air-dried. Dry matter (DM) of samples was determined by oven drying triplicate sub-samples at 65 °C for 72 h, after air-drying (7).

Dried samples were ground to pass through a 1-mm screen before analysis. Ash content of the samples was determined in a muffle furnace at 550 °C for 8 h. All samples were analyzed for crude protein (CP) by the Kjeldahl procedure (7), neutral detergent fiber (NDF) (8), and acid detergent fiber (ADF) (9) content. In vitro DM digestibility (IVDMD) of the samples was determined with the procedure reported by Tilley and Terry (10), as modified by Marten and Barnes (11). Ruminal ingesta from an alfalfa-fed ruminally fistulated ram were hand-collected and strained through 4 layers of cheesecloth to provide the inocula for IVDMD determination. Digestible energy (DE, Mcal/kg) (12), metabolizable energy (ME, Mcal/kg) (12), and net energy for lactation (NEL, Mcal/kg) (13) values were calculated using the following equations:

DE: (Mcal/kg) = TDN × 0.04409;

ME: (Mcal/kg) = Digestible energy × 0.82;

NEL: (Mcal/kg) = 0.00245 × DE – 0.12.

All data were subjected to analysis of variance for a completely randomized design using the GLM procedure of SAS (14).

Results

Table 1 shows the chemical composition of the different vetch mixtures intercropped with barley, conserved as hay. While DM and organic matter (OM) content did not differ, CP, NDF, and ADF content were significantly different between the different vetch mixtures intercropped with barley ($P < 0.05$). CP content of vetch-barley hays ranged from 12.49% to 20.68% and was the highest in the hairy vetch-barley mixture ($P < 0.05$). While the CP content of hairy and wooly pod

Table 1. Chemical composition of 4 different vetch-barley mixtures.

Vetch varieties in mixture	Planting time	DM (%)	Ash (%)	OM (%)	CP (%)	NDF (%)	ADF (%)
Hairy Vetch	I	94.21	9.41^{abc}	90.51^{abc}	15.63^{bc}	51.63^{bc}	35.48^{a}
(Selçuklu-2002)	II	93.96	9.08^{abc}	90.92^{abc}	15.40^{bc}	53.11^{abc}	34.27^{ab}
	III	94.20	10.81^{a}	89.19^{c}	17.13^{b}	50.78^{bc}	32.59^{ab}
Common	I	93.61	7.10^{c}	92.90^{a}	12.92^{c}	49.47^{c}	28.04^{b}
Vetch	II	93.80	7.49^{bc}	92.51^{ab}	12.49^{c}	55.71^{abc}	29.21^{b}
(Farukbey-2001)	III	94.32	9.07^{abc}	90.93^{abc}	12.68^{c}	57.35^{ab}	33.27^{ab}
Hungarian	I	94.06	8.55^{abc}	91.45^{abc}	13.42^{c}	53.09^{abc}	31.80^{ab}
Vetch	II	94.07	8.35^{abc}	91.65^{abc}	13.76^{c}	51.20^{bc}	30.26^{ab}
(Tarım Beyazı-98)	III	94.18	8.93^{abc}	91.07^{abc}	12.58^{c}	56.47^{ab}	30.35^{ab}
Wooly Pod Vetch	I	94.05	8.1^{bc}	91.89^{ab}	13.46^{c}	56.93^{ab}	33.38^{ab}
(Segmen-2002)	II	93.97	6.98^{c}	93.02^{a}	13.60^{c}	58.66^{a}	33.04^{ab}
	III	94.22	10.10^{ab}	89.90^{bc}	20.68^{a}	54.42^{abc}	35.32^{a}
SEM		0.268	0.50	0.49	0.96	2.06	1.64
Planting time		0.29	0.36	0.36	0.01	0.31	0.37
Variety		0.76	0.25	0.24	0.01	0.05	0.01
Plant x Var		0.88	0.28	0.27	0.01	0.12	0.04

$^{a-c}$: Means with different superscripts within a column are significantly different, ($P < 0.05$).

vetches were significantly higher with the third planting than with the first and second plantings, CP contents of common and Hungarian vetches were not affected by planting time ($P > 0.05$). The wooly pod vetch-barley mixture had the highest NDF and the common vetch-barley mixture had the lowest ADF content among the vetch-barley mixtures ($P < 0.05$). Only CP content was significantly affected by planting time ($P < 0.05$).

In vitro DM digestibility values significantly differed among the vetch varieties ($P < 0.05$). Because energy values were calculated from in vitro digestibility values, ME (Mcal/kg) values also significantly differed among the 4 vetch-barley mixtures (Table 2).

DM, IVDMD, and ME yield were significantly influenced by planting time, and CP yield was significantly affected by both planting time and variety ($P < 0.05$) (Table 3).

Discussion

The chemical composition of the 4 different varieties is presented in Table 1. DM concentration of each vetch hay was similar and all were above 93.0%, indicating good drying to conserve as hay. OM content of the vetches was similar and ranged from 89.19% to 93.02%. The OM levels found in the present study were similar to those reported by the NRC (12), and Smith (15). It is well known that the CP content of the same plant varieties can differ significantly (16-18). Planting time significantly affected CP content of the vetch-barley mixtures. As the plant matures, CP content generally goes down. In the current study, even though all of the vetch-barley mixtures were harvested on the same day, there were significant differences in CP content in some of the vetch-barley mixtures planted on different days. These differences could have been the result of the differences in the physiological maturity of the vetch varieties used in

Table 2. In vitro DM digestibility (IVDMD) and energy value of 4 different vetch-barley mixtures.

Vetch varieties in mixture	Planting time	IVDMD, % DM	ME (Mcal/kg)	NEL (Mcal/kg)
Hairy Vetch	I	61.80^{cd}	2.232^{cd}	1.393^{bc}
(Selçuklu-2002)	II	68.08^{ab}	2.393^{abc}	1.500^{ab}
	III	67.83^{ab}	2.453^{ab}	1.583^{a}
Common	I	69.20^{a}	2.500^{a}	1.573^{a}
Vetch	II	62.47^{cd}	2.260^{cd}	1.410^{bc}
(Farukbey-2001)	III	58.57^{d}	2.120^{d}	1.317^{c}
Hungarian	I	59.43^{d}	2.147^{d}	1.337^{c}
Vetch	II	63.21^{bcd}	2.287^{bcd}	1.430^{bc}
(Tarım Beyazı-98)	III	62.82^{bcd}	2.273^{bcd}	1.420^{bc}
Wooly Pod Vetch	I	60.06^{d}	2.170^{d}	1.350^{c}
(Segmen-2002)	II	58.47^{d}	2.113^{d}	1.313^{c}
	III	61.89^{cd}	2.220^{cd}	1.383^{bc}
SEM		1.64	0.06	0.04
Planting time		0.99	0.99	0.99
Variety		0.01	0.01	0.01
Plant x Var		0.01	0.01	0.01

$^{a-d}$: Means with different superscripts within a column are significantly different, ($P < 0.05$).

this study. It is well known that cultivars often differ in physiological maturity (18). CP concentration of the vetch-barley varieties was between 12.49% and 20.68%, which is in agreement with the values reported in the literature (15,18-20). NDF and ADF concentrations were significantly different between the varieties and the highest was in hairy and woolly pod vetches ($P < 0.05$). However, both NDF and ADF values were at the upper edge of the values reported by Al-Masri (5). Botanical composition was not affected by cutting date, but was affected by mixture rates (21). These differences in NDF and ADF values between the 2 studies could be due to differences in mixture rates.

IVDMD and ME values ranged from 58.47% to 69.20% and from 2.113 to 2.500 Mcal/kg, respectively, which are at upper edge of values reported in the literature (12,15). Lithourgidis et al. (22) reported that as ADF increases there is a decline in TDN, which means that animals are not able to utilize the nutrients that are present in the forage. They also speculated that the lowest values for TDN in common vetch are attributed to the high amount of ADF and to the high lignin content. IVDMD of vetch-barley varieties seem to be strongly related to the cell wall components of the mixtures (5,22). The highest digestibility values for each vetch-barley mixture in the present study were observed in those with the lowest cell wall components. This finding is supported by the observation reported by Al-Masri (5).

DM, DDM, and ME (Mcal/kg) yields decreased linearly with planting time. There was a more than 1.5-fold difference in DM yield between the first planting and last planting. A similar pattern was also observed for DDM and ME (Mcal/kg) yields. The differences were mainly caused by the vegetative growth period (23). DM yields

Table 3. DM, IVDMD, CP, and ME yield of 4 different vetch-barley mixtures.

Varieties	Planting	DM yield (kg/ha)	IVDMD yield (kg/ha)	CP yield (kg/ha)	ME yield (Mcal/ha)
Hairy Vetch	I	6138.1^{a}	3788.8^{ab}	967.9^{a}	8460.4^{ab}
(Selçuklu-2002)	II	3950.3^{cde}	2611.4^{cd}	606.4^{bcd}	6244.8^{cdef}
	III	3269.4^{def}	2205.8^{de}	565.9^{bcd}	5385.7^{efg}
Common	I	5883.5^{ab}	4082.3^{a}	759.3^{abc}	10250.2^{a}
Vetch	II	3653.3^{cdef}	2286.0^{cde}	461.8^{cd}	5176.0^{efgh}
(Farukbey-2001)	III	2502.1^{f}	1462.0^{e}	313.2^{d}	3092.2^{h}
Hungarian	I	6175.3^{a}	3674.9^{ab}	825.4^{ab}	7908.0^{bc}
Vetch	II	4924.9^{abc}	3120.4^{bc}	685.3^{abc}	7176.1^{bcde}
(Tarım Beyazı-98)	III	2584.9^{ef}	1618.0^{e}	331.7^{d}	3667.6^{gh}
Wooly Pod Vetch	I	5914.8^{ab}	3519.6^{ab}	806.7^{ab}	7612.1^{bcd}
(Segmen-2002)	II	4582.2^{bcd}	2680.3^{cd}	637.0^{bc}	5669.1^{defg}
	III	3402.6^{def}	2089.5^{de}	702.7^{abc}	4645.9^{fgh}
SEM		434	270	92.4	674
Planting time		0.01	0.01	0.01	0.01
Variety		0.32	0.69	0.04	0.61
Plant x Var		0.51	0.14	0.24	0.02

$^{a-h}$: Means with different superscripts within a column are significantly different ($P < 0.05$).

linearly decreased with planting time due to a reduction in the vegetative growth period. Similarly, Singh et al. (24) reported that the highest yield was obtained when the crop was sown between 10 and 30 October, and yield reductions of 26.4% and 40.2% were obtained when sowing was delayed to 20 November and 10 December, respectively. DM yield ranged from 2502.1 to 6175.3 kg/ha. Our DM yield values were somewhat less than the values reported for barley-vetch mixture sowing (20,23). These differences in DM yield among experiments might be due to ecological conditions, such as precipitation and temperature values recorded (25) during the vegetative period. The cultivars utilized, timing of the experiments (summer and winter sowings), and differences in mixture rates of vetch and barley might also affect DM yield (20). In fact, some cultivator experiments have shown differences in quality and quantity (18) when harvested on common dates, but it is difficult to determine if the differences are confounded by maturity, which often differs among entries (26). Qamar et al. (25) reported that both harvest time and mixture rate affected the DDM and ME yields of vetch-barley mixtures, in which all 3 mixtures of vetch and barley had higher DDM and ME values compared to both of the sole crops.

CP yield was significantly affected by both planting time and variety ($P < 0.05$). CP yield ranged from 313.2 to 967.9 kg/ha, which is similar to values reported in the literature (20,27). The highest CP yield was observed with the mixture of hairy vetch-barley planted on 7 October 2003 (967.9 kg/ha), followed by the mixture of wooly pod vetch-barley planted on 7 October 2003 (806.7 kg/ha). Although these mixtures of vetch-barley did not have the highest CP content among the vetch-barley mixtures, they had the highest CP per hectare values because of their higher forage yield. These results were confirmed by the results reported by Lithourgidis et al. (22).

In conclusion, all of the vetch-barley mixtures had significantly higher DDM and CP yields when planted on 7 October 2003. Thus, October is a better time for planting vetch-barley mixtures in Eastern Anatolia. If a greater CP yield in addition to DDM yield is desired from vetch-barley hay, then common vetch should not be used.

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