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Research Article

Nutrient profile and digestibility of common vetch *(Vicia sativa)* alone or intercropping with different forages

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ABSTRACT

The present study was conducted to assess the nutrient profile, digestibility and feeding values of common vetch alone or intercropping combinations with different cereal and legume forages in central district of Burdur, Türkiye. Approximately 2 kg fresh matter of common vetch alone or 9 different intercropping combinations was harvested from different locations. Nutrient composition and *in vitro* true dry matter digestibility were analyzed whereas feeding values were calculated. The study showed that intercropping largely decreased the crude protein of common vetch while an increase in fiber and carbohydrate fractions was noted except acid detergent fiber and acid detergent lignin that decreased in intercropping mixtures compared to common vetch alone. In addition, there was an increase in digestibility and feeding values in intercropping mixtures in comparison with common vetch alone. In conclusion, intercropping of common vetch with cereal forages improves the nutrient profile, *in vitro* digestibility, and feeding values despite a reduction in the crude protein content of intercropping mixtures compared to common vetch.

INTRODUCTION

Türkiye has been facing the problem of increasing shortage of forage and roughages due to the feeding practices of farmers that give more importance to the cereal straws in comparison with forages (Arslan & Erdurmuş, 2012). Therefore, the total area for growing cereal crops is greater than that of forage crops especially legumes (TÜİK, 2022). Consequently, the production of leguminous forages is insufficient to sustain the protein needs of animal production. This deficit is largely closed by the import of protein concentrates and protein sources that increase the import bill because of the higher prices of protein sources and increased shipping costs since most of the protein sources (soybean, canola, sunflower, and others) are imported from Latin America and North American. In addition to insufficient forage production, the quality of forages grown in dryland regions of Türkiye is low as well due to climatic conditions. Legume forages, being good sources of protein, are capable of closing the gap between protein requirements and protein produced to sustain the animal production of Türkiye (Alatürk et al., 2018). Common vetch *(Vicia sativa)* is one of the best legume forages after alfalfa due to lesser requirement for irrigation that makes it suitable for drylands as well (Parissi et al., 2022). However, lodging of vetch in the crop fields is very common owing to its weaker stems (Bakoğlu & Memiş, 2002). Besides this, legume forages including common vetch, despite having greater crude protein (CP) levels than cereal forages, are less tasteful due to low carbohydrates in these crops (Ansar et al., 2010).

All these problems can be solved by intercropping of common vetch with other crops especially with winter cereal crops (Zhang & Li, 2003; Hauggaard-Nielsen et al., 2006) that increases the dry matter intake (DMI) in ruminants (Ansar et al., 2010). Intercropping of vetch and winter cereal crops either as main or second crop not only prevents the lodging of vetch but also quality losses (Bakoğlu & Memiş, 2002). In addition, intercropping system ensures the sustenance of nutrient supply in animal production and presents a better control of pests, weeds, and diseases in the crops and fields (Szumigalski & Rene, 2005). Although intercropping of common vetch and cereal crops has increased over the last decade, the nutrient composition and digestibility has remained inconclusive due to the availability of various mixtures, mixing ratios, and locations. Therefore, the present study was conducted to evaluate the nutrient composition and *in vitro* digestibility of different common vetch-cereal crop mixtures grown in Burdur, Türkiye.

MATERIALS and METHODS

The study was conducted in Burdur, Türkiye in 2021. The land is located in the central district of Burdur. Forage crops were harvested in early summer (second week of June 2021). Approximately 2 kg fresh matter was harvested from different sites in the same field. Table 1 shows the common vetch and its various mixtures harvested from central district of Burdur province.

Chemical composition of forage crops

Harvested common vetch and various mixtures were sub-

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Table 1. Abbreviations of common vetch and intercropping mixtures

Abbreviation	Forages[1]
1	*Vicia sativa*
2	*Vicia sativa* + *Pisum sativum*
3	*Vicia sativa* + *Avena sativa* L.
4	*Vicia sativa* + × *Triticosecale* Wittmack L.
5	*Vicia sativa* + *Secale cereale*
6	*Vicia sativa* + *Secale cereale* + *Triticum aestivum*
7	*Vicia sativa* + × *Triticosecale* Wittmack L. + *Hordeum vulgare* L.
8	*Vicia sativa* + *Pisum sativum* + *Avena sativa* L.
9	*Vicia sativa* + × *Triticosecale* Wittmack L. + *Triticum aestivum* + *Secale cereale*
10	*Vicia sativa* + *Pisum sativum* + *Triticum aestivum* + *Secale cereale* + *Avena sativa* L.

[1] *Vicia sativa* = vetch, *Pisum sativum* = pea, *Avena sativa* L. = oat, × *Triticosecale* Wittmack L = triticale, *Secale cereale* = rye, *Triticum aestivum* = wheat, *Hordeum vulgare* L = barley

jected to forced air drying for 48 – 72 h in an oven (Memmert BE 500, Memmert GmbH + Co. KG, Schwabach, Germeny) at 65ºC to measure the dry matter (DM) content in triplicates according to the AOAC method (AOAC, 2000; method 934.01).

The dried samples were further subjected to CP, (method 984.13), crude ash (method 942.05), and ether extract (EE; method 920.39) analyses following AOAC methods (AOAC, 2000). Crude fiber (CF), neutral detergent fiber (NDF), and acid detergent fiber (ADF) were analyzed by fiber analyzer (ANKOM A2000 Fiber Analyzer, ANKOM Technology, NY, United States). The nitrogen-free extract (NFE), non-fiber carbohydrates (NFC), hemicellulose (HEC), DMI, digestible dry matter (DDM), relative feed value (RFV), and net energy for lactation (NE_L) and total digestible nutrients (TDN) of common vetch and mixtures were computed according to the formulas below:

$$NFE = 100 – (CP + Crude\ ash + EE + CF)$$

$$NFC = 100 – (CP + Crude\ ash + EE + NDF)$$

$$HEC = NDF – ADF$$

$$DMI = 120 \div NDF$$

$$DDM = 88.9 – (ADF \times 0.779)$$

$$RFV = DMI \times DDM \times 0.775$$

$$NE_L = [1.044 – (0.0119 \times ADF)] \times 2.205$$

$$TDN = (–1.291 \times ADF) + 101.35$$

DMI, DDM, RFV, TDN, and NE_L were calculated according to Horrocks and Vallentine (1999). The chemical analyses were conducted in triplicates, averages were taken, and presented as % DM basis.

In vitro true dry matter digestibility

Common vetch and all the mixtures were incubated in Daisy[II] incubator (Daisy[II] Incubator, ANKOM Technology, NY, United States) to evaluate the *in vitro* DM digestibility. The samples in triplicates were packed in ANKOM F57 filter bags, placed in Daisy[II] incubator bottles, ruminal fluid as inoculum was added, and incubated for 48 hours. The *in vitro* DM digestibility (IVTDMD) was calculated followed by the calculation of organic matter (OM) digestibility.

$$IVTDMD = 100 – [(W_3 – (W_1 \times C_1) \times 100] / W_2$$

W_1 = F57 filter bag weight (g)

W_2 = sample weight (dry matter, g)

W_3 = NDF weight after incubation (dry matter, g)

C_1 = blind weight (g)

Statistical analysis

Due to the individual differences among the mixtures, the data were only subjected to descriptive statistical analysis in computer-aided statistical software package (SPSS; version 22.0; Armonk, NY, USA). The data were presented as mean ± standard deviation.

RESULTS

Table 2 presents the proximate analysis of common vetch alone or in combination with different cereal and legume forages. The DM content of common vetch was 21.96% that increased in mixtures containing triticale, wheat, and rye to 36.23%. Common vetch alone had 86.39% OM content almost similar to that intercropped with oat (86.33%) or rye and wheat combined (86.08%). Other intercropping combinations had greater OM content than common vetch alone although the OM content of intercropping combinations was not relatively very high. Common vetch alone had 15.94% CP. Most intercropping combinations had relatively lower CP content than common vetch except the combination with rye only. The CP content was notably lower in combinations cereal forages except rye and pea. In additions, combination involving multiple cereal and legume forages also had very low CP compared to common vetch or in combination with rye or pea.

The EE content of common vetch was 1.94%. Intercropping of common vetch with rye had very high EE content (3.76%) in comparison with all other forages including common vetch alone. Crude ash content was relatively high in common vetch intercropped with rye and wheat (10.12%) compared to all combinations as well as common vetch alone (9.86%). Intercropping combinations of common vetch with pea, triticale, rye, triticale and barley, and multiple forage combinations had considerably lower crude ash concentrations (8.19, 6.77,8.81, 8.03, 6.73, and 8.71%) than common vetch alone and other intercropping combinations. common vetch alone had 30.11% CF content which was lower in comparison with few intercropping combinations with triticale (31.11%), rye and triticale (31.58%), triticale and barley (36.18%), and pea and oat (32.93%). All the remaining combinations had lower CF concentration than common vetch alone or in combination with the afore-mentioned intercropping combinations. The NFE content of common vetch alone (38.40%) and intercropped with rye and triticale (38.09%), or pea and oat (37.76%) was lower in comparison with other intercropping combinations.

The fiber and carbohydrate fractions of common vetch alone or intercropped with cereal and legume forages have been presented in Table 3. Common vetch had 44.64% NDF, 35.45% ADF, 5.60% ADL, 9.19% HEC, 23.88% NFC, and 68.51% total carbohydrates. Most intercropping mixtures exhibited greater levels of NDF, HEC, NFC, and total carbohydrates whereas lower ADF, ADL were seen.

The digestibility and feeding values of common vetch alone or intercropped with cereal and legume forages has been depicted in Table 4. The IVTDMD, IVOMD, DMI, DDM, RFV, TDN, NE_L of common vetch were 51.56%, 48.18%, 2.69%, 61.29%, 127.89%, 55.59, and 1.37 Mcal/kg, respectively. Intercropping of common vetch increased the IVTDMD and IVTOMD except oat that decreased the IVTDMD and IVTOMD compared to common vetch alone. Common vetch alone had lower DDM, TDN, and NE_L than intercropping mixtures. The RFV of intercropping mixtures was relatively greater than common vetch alone except the intercropping with triticale, rye and triticale, and triticale and barley.

DISCUSSION

Karslı et al. (2005) reported that the DM content ranges between 15.25% and 24.46% in different varieties of common vetch. Intercropping of common vetch with oat had lower DM (18.97%) than that of common vetch alone. This might be attributed to the late maturity of oat due to severe cold climatic conditions of Burdur that prevent the early maturity of oat. Similar CP content of common vetch was reported in previous studies (Lithourgidis et al., 2006; 2007). In contrast, most studies have reported greater CP content of common vetch as opposed to the CP in this study (Karslı et al., 2006; Budakli Carpici & Celik, 2014; Georgieva et al., 2016; Pereira et al., 2020). Karslı et al. (2005) reported that the CP, OM, and crude ash of common vetch varies between 17.75 and 20.30%, 87.36 and 89.6%, and 10.2 and 12.64%, respectively. CP content of common vetch was 21% (Budakli Carpici & Celik, 2014) whereas, CP and crude ash was reported as 24.5% and 8.54%, respectively (Pereira et al., 2020). Similarly, CP and CF ranged from 18.24 to 19.04%, and 25.40 to 26.48%, respectively (Georgieva et al., 2016). Consistent with this study, intercropping of common vetch with oat, barley, triticale, wheat, rye gradually reduced the CP content compared to common vetch alone (Lithourgidis et al., 2006; 2007; Balabanlı et al., 2010; Budakli Carpici & Celik, 2014; Najera et a., 2016). In general, cereal forages are a poor source of CP as opposed to common vetch since common vetch is a legume forage. Therefore, intercropping of common vetch with cereal crops also lowers the CP content of the intercropped mixtures that supports the idea of this study.

Table 2. Proximate analyses of common vetch alone or intercropping with cereal and legume forages (%, dry matter basis)

Forages	Nutrients[1]						
	DM	OM	CP	EE	Crude ash	CF	NFE
1	21.96 ± 2.96	86.39 ± 0.45	15.94 ± 0.29	1.94 ± 0.29	9.86 ± 0.16	30.11 ± 1.30	38.40 ± 2.25
2	24.26 ± 0.38	88.08 ± 0.17	15.68 ± 0.34	1.17 ± 0.31	8.19 ± 0.30	25.90 ± 2.63	45.34 ± 1.93
3	18.97 ± 0.44	86.33 ± 0.38	13.19 ± 0.92	1.87 ± 0.40	9.36 ± 0.45	28.54 ± 1.36	42.73 ± 3.77
4	32.64 ± 0.01	89.87 ± 0.23	11.41 ± 0.06	1.39 ± 0.02	6.77 ± 0.28	31.11 ± 0.43	45.96 ± 0.12
5	27.27 ± 0.01	87.77 ± 0.08	16.39 ± 0.92	3.76 ± 0.23	8.81 ± 0.09	27.54 ± 0.17	40.09 ± 0.23
6	21.71 ± 0.01	86.08 ± 0.07	15.40 ± 0.19	1.03 ± 0.14	10.12 ± 0.06	31.58 ± 0.29	38.09 ± 0.54
7	25.48 ± 0.01	87.90 ± 0.14	10.92 ± 0.32	1.47 ± 0.10	8.03 ± 0.08	36.18 ± 0.83	39.34 ± 0.57
8	24.27 ± 0.01	87.10 ± 0.13	15.21 ± 0.38	1.21 ± 0.16	9.66 ± 0.02	32.93 ± 0.63	37.76 ± 0.28
9	36.23 ± 0.01	90.46 ± 0.16	9.78 ± 0.25	1.43 ± 0.05	6.73 ± 0.16	27.96 ± 0.16	51.31 ± 0.51
10	30.95 ± 0.01	87.12 ± 0.66	11.81 ± 0.14	2.18 ± 0.27	8.71 ± 0.06	26.50 ± 0.38	46.63 ± 0.42

[1]DM = dry matter, OM = organic matter, CP = crude protein, EE = ether extract, CF = crude fiber, NFE = nitrogen free extract

Previous studies reported similar fiber and carbohydrate fractions of common vetch (Karslı et al., 2005; Lithourgidis et al., 2006; 2007; Budakli Carpici & Celik, 2014; Georgieva et al., 2016). The NDF and ADF contents of common vetch were 40.76-49.36% and 28.14-32.91% (Karslı et al., 2005). Similarly, common vetch was reported to have 44.31% NDF, 36.58%

Table 3. Fiber and carbohydrate fractions of common vetch alone or intercropping with cereal and legume forages (%, dry matter basis)

Forages	Item[1]					
	NDF	ADF	ADL	HEC	NFC	Total CHO
1	44.64 ± 1.71	35.45 ± 1.29	5.60 ± 0.11	9.19 ± 0.48	23.88 ± 0.85	68.51 ± 1.03
2	43.91 ± 1.96	28.64 ± 0.39	4.02 ± 0.34	15.28 ± 0.64	27.32 ± 0.32	71.23 ± 0.72
3	44.83 ± 0.44	29.40 ± 0.99	3.59 ± 0.86	15.44 ± 0.35	26.44 ± 1.00	71.27 ± 0.68
4	48.07 ± 0.33	30.32 ± 0.27	4.69 ± 0.76	17.75 ± 0.06	29.01 ± 0.02	77.07 ± 0.31
5	38.64 ± 0.09	26.31 ± 0.10	4.04 ± 0.21	12.33 ± 0.18	28.99 ± 0.16	67.63 ± 0.06
6	51.65 ± 0.64	32.63 ± 0.25	4.02 ± 0.32	19.02 ± 0.38	18.01 ± 0.89	69.66 ± 0.25
7	59.00 ± 0.14	35.42 ± 0.01	3.37 ± 0.27	23.58 ± 0.13	16.52 ± 0.13	75.51 ± 0.27
8	44.45 ± 0.45	32.53 ± 0.30	5.07 ± 0.44	11.92 ± 0.75	26.24 ± 0.80	70.69 ± 0.35
9	48.38 ± 0.35	27.02 ± 0.55	2.64 ± 0.14	21.36 ± 0.21	30.89 ± 0.01	79.27 ± 0.35
10	46.48 ± 0.16	28.00 ± 0.32	4.27 ± 0.04	18.39 ± 0.49	26.65 ± 0.63	73.13 ± 0.79

[1]NDF = neutral detergent fiber, ADF = acid detergent fiber, ADL = acid detergent lignin, HEC = hemicellulose, NFC = non-fiber carbohydrates, Total CHO = total carbohydrates

Table 4. *In vitro* rumen digestibility and feeding values of common vetch alone or intercropping with cereal and legume forages (%)

Forages	Item[1]						
	IVTDMD	IVTOMD	DMI[2]	DDM	RFV	TDN	NE_L[3]
1	51.56 ± 2.25	48.18 ± 2.26	2.69 ± 0.10	61.29 ± 1.00	127.89 ± 3.49	55.59 ± 0.66	1.37 ± 0.04
2	57.54 ± 3.01	50.45 ± 2.48	2.80 ± 0.05	66.59 ± 0.30	144.66 ± 3.37	64.38 ± 0.51	1.55 ± 0.01
3	47.65 ± 2.05	39.79 ± 1.75	2.68 ± 0.03	66.00 ± 0.33	136.90 ± 1.94	63.40 ± 0.86	1.53 ± 0.08
4	61.14 ± 2.08	55.39 ± 1.56	2.50 ± 0.02	65.29 ± 0.21	126.32 ± 0.91	62.21 ± 0.34	1.51 ± 0.01
5	60.12 ± 1.32	52.71 ± 1.44	3.11 ± 0.01	68.41 ± 0.08	164.66 ± 0.15	67.39 ± 0.13	1.61 ± 0.01
6	54.28 ± 1.65	45.58 ± 1.36	2.32 ± 0.03	63.48 ± 0.20	114.32 ± 1.25	59.23 ± 0.32	1.45 ± 0.01
7	53.17 ± 1.60	46.42 ± 1.21	2.04 ± 0.01	61.31 ± 0.01	96.65 ± 0.17	55.63 ± 0.01	1.37 ± 0.01
8	52.16 ± 0.97	44.04 ± 0.72	2.70 ± 0.03	63.56 ± 0.32	133.00 ± 0.62	59.36 ± 0.39	1.45 ± 0.01
9	65.30 ± 2.28	61.01 ± 0.21	2.48 ± 0.01	67.85 ± 0.42	130.45 ± 1.24	66.47 ± 0.71	1.59 ± 0.01
10	59.24 ± 1.51	52.18 ± 1.44	2.62 ± 0.01	67.10 ± 0.25	134.26 ± 0.02	65.22 ± 0.42	1.57 ± 0.01

[1]NDF = neutral detergent fiber, ADF = acid detergent fiber, ADL = acid detergent lignin, HEC = hemicellulose, NFC = non-fiber carbohydrates, Total CHO = total carbohydrates

ADF, and 6.85% ADL (Lithourgidis et al., 2006). These researchers, in 2007, reported that common vetch had 43% NDF, 30.4% ADF, 6.74% ADL, and 11.6% HEC (Lithourgidis et al., 2007). Budakli Carpici & Celik (2014) reported 55% NDF and 32% ADF in common vetch. Likewise, NDF, ADF, ADL, and HEC contents of common vetch were 38.03-44.67%, 31.62-39.69%, 5.17-9.33%, and 2.96-8.20%, respectively (Georgieva et al., 2016). Inconsistent results have been reported regarding the fiber levels in intercropped mixtures of common vetch with cereal crops. Partly in line with the findings of this study, intercropping of common vetch with cereal forages increased the NDF and HEC while decreased the ADF and ADL contents (Lithourgidis et al., 2006; 2007; Budakli Carpici & Celik, 2014; Georgieva et al., 2016; Najera et al., 2016). In contrast, Pereira et al. (2020) reported the intercropping of common vetch had no effect on the NDF and ADF contents of common vetch.

Georgieva et al. (2016) reported that the IVTDMD and IVTOMD of different common vetch varieties ranges between 57.7 to 66.2%, and 57.5 to 66.9%. In contrast, the IVTDMD of common vetch varieties differed between 60.96 and 64.67% (Karslı et al., 2005). Lithourgidis et al. (2006) reported 2.71% DMI, 60.4% DDM, 44.15% TDN, 126.85% RFV, and 1.34 Mcal/kg NE_L of common vetch. Similarly, the RFV, TDN, and NE_L of common vetch were 110.4%, 61.9%, and 1.36 Mcal/kg, respectively (Najera et al., 2016).

This study showed that while concentrations of most nutrients, digestibility, and feeding values of common vetch alone or intercropping with cereal forages were consistent with the existing body of literature, there were also differences. It is liable to suppose that these differences might be attributed to the differences in study location, climatic conditions, annual rainfall, soil structure, soil fertilization, agronomic practices, weed control, varieties of forages, seed rate, and the ratios of seeds in intercropping mixtures. The limitation of this preliminary study was to collect the common vetch and intercropping mixtures from the already sown fields that rendered the researcher devoid of the valuable sowing information, agronomic practices, soil structure, and ratios of seeds in intercropping of common vetch with other forages.

CONCLUSION

In conclusion, the present study showed that common vetch alone or intercropped with certain cereal forages yields forages for animals rich in nutrients with varying degrees of digestibility and feeding values. Although intercropping reduces the crude protein, it may improve the fiber and carbohydrate fractions and digestibility. Experimental studies are necessary to evaluate the ratios of seeds in intercropping mixtures.

DECLARATIONS

Ethics Approval

The present study does not require ethics committee approval.

Conflict of Interest

The author state that no commercial funding was acquired for this study that may be construed as potential conflict of interest.

Consent for Publication

Not applicable.

Author contribution

Idea, concept and design: EK

Data collection and analysis: EK

Drafting of the manuscript: EK

Critical review: EK

Data Availability

The data are available from the corresponding author on reasonable request.

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