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The conservation method effects of the Barley-Vetch mixture planted together on the performance of pregnant ewes

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Abstract: The aim of this study was to examine the effects of barley-vetch hay and barley-vetch silage on liveweight change in pregnant sheep and birthweight in lambs and to determine the optimal form of barley-vetch roughage usage in sheep feeding. Forty-eight (Kıvırcık x Akkaraman (G_1) sheep were blocked according to age and randomly distributed to three groups: barley-vetch hay (H, n = 16), barley-vetch silage (S, n = 16), and the control group (C, n = 16). The H group was fed barley-vetch hay *ad libitum* and limited concentrate, the S group was fed barley-vetch silage *ad libitum* and limited concentrate, and the C group was fed barleygrass straw + alfalfa hay (50/50%) and limited concentrate feed. The trial was started in the final trimester period of the pregnancy and lasted 90 days. Liveweight and feed intake of the pregnant sheep were recorded in the last period of pregnancy. The liveweight of the lambs were measured at lambing and then on d 15 and 30. There is no diet effect on liveweights measure 1 and 2 months after lambing ($p > 0.05$). The liveweight value of sheep at lambing was 67.01 ± 1.32, 64.07 ± 1.54, and 64.89 ± 1.48 kg for the groups H, S, and C, respectively. The birth type was significant on birth weight ($p < 0.05$). Lamb liveweights on d 15 and 30 for the group H was greater than those for the group S ($p < 0.05$). Lambs' birth weight and weights on d 15 and 30 were 4.94 ± 0.13, 4.44 ± 0.15, and 4.77 ± 0.17 kg; 9.30 ± 030, 8.03 ± 0.30, and 8.94 ± 0.34, 13.36 ± 0.43, 10.85 ± 0.56, and 12.37 ± 041 for groups respectively. In conclusion, barley-vetch mixture can be used as hay and silage in pregnant sheep feeding, being hay superior to silage.

Key words: Barley-vetch, silage, lamb performance

1. Introduction

Animal food has an important role in human nutrition. Among these foods, meat, milk, and eggs are the main ones [1,2]. It is estimated that the world population will be 9 billion in 2050 and the need for animal products will increase by 60-70% [3,4]. Also, the global pandemic conditions affected animal production negatively. Therefore, in order to increase the yield and quality of livestock enterprises, alternative production models should be applied, and the use of existing crops should be integrated [5,6]. In order to maintain the current production, it is necessary to increase the number of animals or increase the productivity [7]. Considering these facts, adequate nutrition intake of animals should be ensured in order to increase the livestock products [8].

Small ruminant has an important role in meat and milk production in Turkey as well as in the world [9,10]. Mutton production occupies a larger place among the small ruminant. Meat obtained from small ruminant meets 11.3% of the world's total meat production and 25% in Turkey [4]. Serious yield can be achieved due to the increase of the yield per unit animal. Feeding of sheep is mostly based on pasture. Important periods in sheep nutrition include flushing, gestation, and lactation periods [11]. The growth of fetus to about 70% of adult growth takes place in the last 1/3 period of the pregnancy. The quality and adequate feed should be offered to the animals in this period [12].

The wheatgrass straw and dry grass are preferred as roughage for feeding pregnant sheep in Turkey conditions. [13]. However, wheatgrass straw is not enough to meet the nutritional needs of the animals. Therefore, it is necessary to increase the production of quality roughage resources to meet the needs of livestock enterprises. Considering the reasons such as decreasing water resources in the world, climate change, and the deterioration of soil structure, the production and use of roughage resources, which require minimum water, should be increased [14]. For this reason, two croppings and evaluation of fallow fields are widely used around the world [15,16–17]. One of the roughage sources is the vetch that can be evaluated for this purpose. Vetch can be fed to animals in the form of grass, silage, or

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grain [18]. It is recommended that vetch is to be planted as a mixture with grains, as the stem problem occurs during the end of the flowering period [19]. It is preferred to plant it together with barley or oats and obtain successful results from ensiled as grass-legume hay [20]. It could be more appropriate to consider it as silage, due to the drying problems in the heavy rainy regions [21]. There are many studies on the ratio of vetch and wheatgrass mixed plantings, and although regional differences are important, it is recommended to use 60%–75% of vetch [22,23,24].

Studies on sheep and lambs are generally dealt with grain vetch [25,26]. The study on Akkaraman lambs and yards performance [27], there was no difference between the performance of the animals that consumed *ad libitum* vetch+barley and 500 g/d concentrate. In another study examining the effects of oat vetch on the fattening performance of weaned lambs [28], lambs fed oat vetch had better daily liveweight gain, and body weight at the end of fattening, as well as better carcass weight, and carcass efficiency as compared to the lambs that were grazing on natural pasture. In a comparison of lentil straw and vetch straw to alfalfa hay and wheatgrass straw [29], it was observed that sheep fed vetch straw gained more body weight, and that the nutritional value of vetch straw was much better than wheatgrass straw. Furthermore, it was stated that the use of oat+vetch hay was economical [30], and 100 g concentrate and 200 g oat vetch mixtures added to pasture were suitable and profitable in lamb fattening [31]. In a study examining the effect of the vetch, which was left in the field to analyze the lamb fattening performance [32], the lambs were allowed to graze on vetch stubble, 50/50% vetch+wheat stubble, and wheat stubble for 6 h, and it was observed that the lambs grazing only on vetch and vetch+wheat stubble gained 3 times more liveweight than those grazing only on wheat stubble. The purpose of this study was to investigate the form of barley-vetch as hay and silage in pregnant sheep feeding and its carry-over effects on lamb performance.

2. Material and methods

This study was carried out by International Center for Livestock Research and Training Ethical Committee Report No:167. The animal material of the study was obtained from the Department of Small Ruminants, International Center for Livestock Research and Training (ICLRT), which was comprised of 3–5 years old, 48 Lalahan (Kıvırcık x Akkaraman, B_1) sheep and lambs. Sheep were blocked by the age (3,4 and 5) and assigned into three diets: the control group was fed barleygrass straw + alfalfa hay (50/50%) (C, n = 16), barley-vetch hay (H, n = 16), and barley-vetch silage (S, n = 16). All groups had limited concentrate. Ages, initial liveweights, and days of gestation are given in Table 1.

Table 1. The age, initial liveweight, and day of gestation of sheep.

Groups	Age	LWMS (kg)	Gestation (d)
Hay	4.63 ± 0,29	57.63 ± 1,45	98.44 ± 3,07
Silage	4.53 ± 0,29	57.04 ± 1,37	95.67 ± 3,57
Control	4.79 ± 0,30	57.80 ± 1,16	103.36 ± 3,81
P value	0.833	0.918	0.308

LWMS: Live weight at the mating season. Data are Mean ± SE. N per group is 16.

The nutrient requirements of animals [33] were determined after a week of an adaptation period. The composition of the concentrate and ingredients of rations are given in Table 2.

The roughages were planted as 70% Hungarian vetch and 30% barley (Tarım 92) in the fields of ICLRT in November and harvested in June. Barleygrass straw was obtained from ICLRT and alfalfa hay local market. Fresh grass and hay yield was calculated during the harvest time. It was calculated by throwing a circle on an area of 1 m^2. Approximately 3 tons of the grasses were cut in 2–4 cm sizes in the silage machine and then ensiled using the classical method. The other grass was dried in the field for 1 day before baling.

After grinding to pass a 1 mm sieve, the feed samples were analyzed for DM, OM, CA, CP, and EE [34]. Neutral detergent fiber, ADF, ADL, and CS was analyzed according to Van Soest et al. [35] using Ankom 200. Organic acid levels (lactic, acetic, propionic, butyric, isobutyric, isovaleric acid) were determined in high-performance liquid chromatography (HPLC, Hewlett Packard, Series 1100) [36] after preparing silage samples as outlined by Tjardes et al. [37]. The metabolic energy of the concentrates was calculated according to TSE 9610 [38] modified by Sauvant and Morand [39].

To determine in situ DM, OM, and CP of barley-vetch, 3 ruminally cannulated Holstein cows were used. Approximately 5 g sample with 2 mm particle size introduced into nylon bag with 45 µ pore size. Samples were placed to rumen for 0, 2, 4, 8, 16, 24, 48, and 72 h for incubation [40]. The DM, OM, and CP degradability of feeds were calculated with following equation: $a+b(1-e^{-ct})$. Also in vitro OM digestibility of silage samples was also determined based on Tilley and Terry [41] modified by Marten and Barnes [42] using the Daisy II incubator (ANKOM®, Fairport, New York, USA).

After testing for normality, the difference between the groups and their interactions by the time were analyzed using one-way ANOVA. The group differences were attained using the Tukey test in commercial software (Minitab16) [43].

Table 2. Composition of concentrate and ration of consumed feed by animals.

Concentrate %						
Feed	Barley	Wheat bran	Sun flower seed meal	Calcium	Salt	Vit-Min
Rate (%)	62	17.4	18	2	0.5	0.1
Feed Consumption, g						
	1. Month			2. and 3. Months		
Feeds (g)	Hay	Silage	Control	Hay	Silage	Control
Concentrate	875	875	875	1000	1000	1000
Barley-Vetch hay	1500	-	-	1500	-	-
Barley-Vetch silage	-	2125	-	-	2125	-
Alfalfa hay	-	-	750	-	-	750
Barleygrass straw	-	-	625	-	-	625

3. Results

The amount of fresh hay of barley-vetch was 2120.50 kg/da, and the hay yield was 782.70 kg/da. Dry matter, nature DM, CA, CP, EE, NDF, ADF, ADL, ME, and in vitro digestibility of feeds are given in Table 3. Initial liveweights, age, and day of pregnancy were similar. Liveweights of sheep at lambing and on d 15 and 30 are given in Table 4. The consumption of nutrients and requirements of sheep [33] at the beginning of the experiment, late gestation, and early lactation period are given in Table 5.

4. Discussion and conclusion

Drying and silage are important storage method for green roughage. In this study, the effects of barley-vetch hay and silage were investigated on the live weight of pregnant sheep. Although it is considered that the fresh yield varies according to the climate and region, the fresh yield was obtained in the study was higher than Acar and Mülayim [44] and Ay and Mut [45], and similar to Balabanlı et al [6]. The reason for this difference may depend on the climatic structure of the regions and the planting period) must remove. A high DM value is related to the harvest time. The DM of the barley-vetch hay was similar with Bingöl et al. [5], and Civaner [8].

No difference is expected between fresh and silage DM. However, there was a difference in DM because the time between the cutting and ensiling was prolonged. It is important to silo in a short time after the cutting. The silage DM was higher in the study than in the former studies. [1, 46, 47].

The CA, EE, NDF and ADF values of barley-vetch hay and silage were similar in the study. Only the CP was higher in barley–vetch hay. In general, the CP was lower than similar studies [5, 45, 47]. It is thought that the low CP is associated with the DM. The CA, NDF, and ADF was similar to the former studies [1, 5, 6]. The literature [1, 5] supports that the CP, NDF and ADF levels are related to the cutting time.

In vitro digestibility indicates that the digestibility of feeds. Digestibility decreases when NDF and ADF increased in the feeds [12]. In vitro digestibility of barley-vetch hay was higher than silage. It is thought to be due to the high NDF and ADF content of the silage. The literature [5, 48] supports that the low IVD values of feeds with high NDF and ADF content.

In situ digestibility is an important indicator for determining the digestibility levels of feeds in the rumen. In situ OM digestibility of barley-vetch hay and silage was similar. The 0^{th} hour in situ CP digestibility of silage was higher than hay. This suggests that the NPN content of silage was high. Total CP digestibility of hay was higher than silage. This can be explained by the difference of NDF and ADF. In situ digestibility was lower than Karslı et al. 2006 [49] and Turgut et al. [50].

Lamb development of 70% takes place in the last 1/3 of pregnancy [12]. Therefore, feeding in the last 1/3 of pregnancy affects of lamb development and birth weight. There was no difference between the groups in terms of birth weight of lambs ($p>0.05$). It was observed that the roughage type did not affect the birth weight. However, hay group lambs were better development in terms of 15th and 30th day liveweight ($p < 0.05$). This situation is thought to be due to the net nutrient consumed by the animal is high due to the low NDF and ADF content of barley-vetch hay. In the literature, sheep fed vetch straw were gained more liveweight and better digested than the fed wheat straw [50], and lambs fed vetch in different varieties were better than those fed alfalfa in terms of nutrient digestibility, live

Table 3. Chemical composition, in vitro digestibilities (%), and in situ degradabilities of feeds.

	DM	NDM	CA	CP	EE	NDF	ADF	ADL	ME (Mcal/kg)
Concentrate	89.65		3.93	13.28	2.13	29.9	12.39	2.61	2.9
Fresh barley-vetch		36.92	7.12	9.94	2.33	51.86	35.69	3.86	1.75
Barley-vetch hay	92.21		6.56	8.75	1.37	54.85	33.75	4.42	1.72
Barley-vetch silage		59.63	5.28	7.21	1.17	59.87	37.3	4.95	1.64
Alfalfa hay	91.96		12.71	13.72	1.76	50.09	38.74	8.55	2.08
Barleygrass straw	90.22		7.27	6.33	1.70	68.56	48.01	8.92	1.55

In-vitro Digestibility				
	IVDMD	**IVCPD**	**IVNDFD**	**IVOMD**
Barley-vetch hay	65.22 ± 0,79	83.70 ± 0.29	44.83 ± 1.03	65.78 ± 1.08
Barley-vetch silage	58.80 ± 1,18	70.45 ± 0.69	53.62 ± 1.50	60.06 ± 0.57

In situ OM Degradability								
Groups	**0**	**2**	**4**	**8**	**16**	**24**	**48**	**72**
BVH	32.71	43.94	47.49	51.83	58.75	60.34	69.73	71.85
BVS	32.80	40.27	43.36	49.15	53.83	56.00	68.71	71.85
In situ CP Degradability								
BVH	52.10	70.47	74.22	78.73	79.51	80.22	80.88	80.88
BVS	63.79	64.79	68.70	74.11	74.88	75.02	75.02	75.17

DM; Dry matter, NDM; nature dry matter, CA; crude ash, CP; crude protein, NDF; neutral detergent fiber, ADF; acid detergent fiber, ADL; acid detergent lignin, ME; metabolic energy.
IVDMD; in vitro dry matter digestibility, IVCPD; in vitro crude protein digestibility, IVNDFD; in vitro neutral detergent fiber digestibility, IVOMD; in vitro organic matter digestibility.
BVH: Barle-vetch hay, BVS: barley-vetch silage.

Table 4. Liveweights of sheep at lambing and on d 15 and 30.

Groups	n	Birth LW (kg)	n	15 th Day LW (kg)	n	30 th Day LW (kg)
Hay	16	4.94 ± 0.13	15	9.30 ± 0.30^{a}	12	13.36 ± 0.43^{a}
Silage	21	4.44 ± 0.15	12	8.03 ± 0.29^{b}	6	10.85 ± 0.56^{b}
Control	18	4.77 ± 0.17	12	8.94 ± 0.34^{ab}	11	12.37 ± 0.41^{ab}
P values		0.064		0.018		0.006

weight gain, and performance [48]. Again, Haddad and Husein [29] reported that vetch hay instead of wheat straw gives better results on live weight gain of lambs. It has been reported that 33% and more vetch hay has a positive effect on lamb performance in the fattening period [51].

There was no difference between the groups in terms of live weight of sheep during early pregnancy, late pregnancy, and early lactation period. All groups had live weight gain in accordance with the gestational period. The DM, CP and ME consumptions of the animals were higher in the group H than in the group S. Increasing the DM consumption has positive effects on the development of pregnant animals. Since feed intake is inversely proportional to NDF, DM consumption was higher in hay group. In addition, dry matter consumption is higher in rations which ingredient 50% moisture roughage [33]. In

Table 5. Nutrient consumption and requirements of sheep in the beginning of fattening, late gestation, and early lactation periods (38).

Groups	n	Gestation Day	LW (Kg)	LWG (kg)	RDM (Kg)	CDM (Kg)	DMCR %	RCP (g)	CCP (g)	CPCR %	RME (g)	CME (g)	MECR %
Beginning of fattening (pregnancy of 100. day)													
Hay	16	98.44 ± 3.07	61.08 ± 1.34	0.034 ± 0.01	1.69 ± 0,03	1.83 ± 0.04^{a}	1.08 ± 0.01	128.94 ± 4.88	184.39 ± 4.03^{a}	1.45 ± 0.05^{a}	3.05 ± 0.11	3.64 ± 0.08^{a}	1.21 ± 0,04^{a}
Silage	16	95.67 ± 3.57	60.60 ± 1.25	0.037 ± 0.01	1.64 ± 0.04	1.67 ± 0.03^{b}	1.03 ± 0.02	136.67 ± 5.12	153.12 ± 3.16^{b}	1.14 ± 0.05^{b}	3.18 ± 0.12	3.24 ± 0.07^{b}	1.04 ± 0,04^{b}
Control	16	103.36 ± 3.81	61.77 ± 1.58	0.037 ± 0.01	1.65 ± 0.04	1.73 ± 0.04^{ab}	1.05 ± 0.03	136.93 ± 6.66	190.02 ± 4.86^{a}	1.42 ± 0.06^{a}	3.15 ± 0.15	3.20 ± 0.08^{b}	1.03 ± 0,04^{b}
P values		0.308	0.841	0.941	0.571	***0.022***	0.127	0.506	***0.001***	***0.001***	0.734	***0.001***	***0.001***
Late Gestation													
Hay	16	122.44 ± 3.07	68.18 ± 1.47	0.30 ± 0.02	1.81 ± 0.03	2.17 ± 0.05^{a}	1.20 ± 0.01^{a}	144.81 ± 4.11	225.20 ± 4.86^{a}	1.56 ± 0.03^{a}	3.37 ± 0.11	4.44 ± 0.10^{a}	1.32 ± 0,03^{a}
Silage	15	119.67 ± 3.57	67.34 ± 1.53	0.28 ± 0.02	1.82 ± 0.03	1.91 ± 0.04^{b}	1.05 ± 0.01^{c}	148.73 ± 5.01	191.28 ± 4.35^{b}	1.30 ± 0.03^{b}	3.49 ± 0.13	3.62 ± 0.08^{b}	1.05 ± 0,03^{c}
Control	14	127.36 ± 3.81	68.06 ± 1.90	0.26 ± 0.03	1.81 ± 0.04	2.05 ± 0.06^{ab}	1.13 ± 0.01^{b}	146.57 ± 6.39	230.21 ± 6.44^{a}	1.59 ± 0.04^{a}	3.43 ± 0.16	3.94 ± 0.11^{b}	1.16 ± 0,03^{b}
P values			0.925	0.626	0.975	***0.002***	***0.001***	0.862	***0.001***	***0.001***	0.815	***0.001***	***0.001***
Early Lactation													
Hay	16	149.75 ± 0.54	67.01 ± 1.32		1.92 ± 0.05	2.28 ± 0.05^{a}	1.19 ± 0.02^{a}	209.69 ± 7.80	240.08 ± 4.71^{a}	1.16 ± 0.03^{a}	3.55 ± 0.11	4.72 ± 0.09^{a}	1.34 ± 0,03^{a}
Silage	15	152.67 ± 1.74	64.07 ± 1.54		1.88 ± 0.05	2.02 ± 0.05^{b}	1.08 ± 0.02^{b}	225.80 ± 9.14	206.17 ± 4.96^{b}	0.93 ± 0.04^{b}	3.75 ± 0.13	3.91 ± 0.09^{b}	1.05 ± 0,03^{c}
Control	14	149.86 ± 0.82	64.89 ± 1.48		1.85 ± 0.06	2.16 ± 0.05^{ab}	1.18 ± 0.02^{a}	217.60 ± 11.70	245.09 ± 5.60^{a}	1.15 ± 0.04^{a}	3.66 ± 0.16	4.23 ± 0.10^{b}	1.17 ± 0,03^{b}
P values		0.137	0.330		0.581	***0.002***	***0.001***	0.485	***0.001***	***0.001***	0.570	***0.001***	***0.001***

LW; live weight, LWG; live weight gain, RDM; requirements os dry matter, CDM; consumption of DM, DMCR; DM coverage rate, RCP; requirements of crude protein, CCP; consumption of CP, CPCR; CP coverage rate, RME; requirements of metabolic energy, CME; consumption of ME, MECR; ME coverage rate.
Data are Mean ± SE.

this study, DM consumption was lower in the group S due to high amount of moisture. This agrees with the literature [33]. The pregnant sheep were fed with alfalfa and vetch hay [52]; it was stated that no adverse events were found, and vetch can be given safely.

In summary, barley-vetch mixture hay and silage are quality roughage sources for sheep. Both forms can be used safely alone in the feeding of pregnant sheep, and it does not cause any health problems or low productivity. However, considering lamb development, the H form was superior to the S form.

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