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Mısır Silajı ve Ayçiçeği Silajı ile Farklı Düzeylerdeki Karışımlarının Kıvırcık Kuzuların Besi Performansına Etkileri

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ÖZ

Mısır silajı, dünya genelinde geviş getiren hayvanların beslenmesinde yaygın olarak kullanılan bir kaba yem kaynağıdır. Bununla birlikte, mısır, soğuk ve kurak iklimlerde pahalı ve yetiştirilmesi zor bir üründür. Bu durum, ülkemizde silaj kullanımının yaygınlaşmasını olumsuz yönde etkileyen faktörlerden biridir. Bu nedenle, mısır silajı üretiminin ekonomik olmadığı bölgeler için alternatif bitkilerden silaj üretimi konusu gündeme gelmiştir. Söz konusu silajlık bitkilerinden biri de soğuk ve kurak iklimlerde yetiştirilebilen ayçiçeğidir. Bu çalışmada, mısır ve ayçiçeği silajı ile bunların farklı oranlarda karışımlarının kuzuların besi performansı üzerindeki etkilerinin araştırılması amaçlanmıştır. Çalışmada, hayvan materyali olarak 2,5-3 aylık yaşta ve ortalama canlı ağırlığı 23-25 kg olan 40 adet Kıvırcık erkek kuzu kullanılmıştır. Deneme, yarı açık bir ahırda 56 gün boyunca gerçekleştirilmiştir. Deneme düzenine göre, hayvanlar 5 farklı silaj grubuna (100 mısır silajı, %75 mısır silajı+%25 ayçiçeği silajı, %50 mısır silajı+%50 ayçiçeği silajı, %25 mısır silajı+%75 ayçiçeği silajı, %100 ayçiçeği silajı) ayrılmıştır ve her grupta 8 kuzu bulunmuştur. Kuzular, deney süresince bireysel bölmelerde barındırılmış ve bireysel olarak beslenmiştir. Silajlar ad libitum verilmiş ve ek olarak 0-21, 22-42 ve 43-56 günleri arasında günlük sırasıyla 700, 900 ve 1400 g konsantre yem verilmiştir. Besi süresince, canlı ağırlık, günlük canlı ağırlık artışı, yem tüketimi ve yem dönüşüm oranı değerleri belirlenmiştir. Deneme süresince farklı silaj gruplarının canlı ağırlık değerleri arasındaki farklılıklar önemli bulunmamış ve 8 hafta sonunda elde edilen değerler 35.9 ile 37.4 kg arasında değişmiştir. Farklı silaj türleriyle beslenen kuzuların silaj tüketimi, 0-2 ve 6-8 haftalarında önemli farklılıklar göstermiştir ($p<0.05$). Sonuç olarak, kuzu besisinde mısır silajının %100'üne kadar ayçiçeği silajı ile ikame edilmesinin besi performansı üzerinde herhangi bir olumsuz etkisinin olmadığı belirlenmiştir. Hem besi performansı hem de tüketim seviyeleri göz önünde bulundurularak, ayçiçeği silajının, özellikle kış koşullarının sert olduğu, sulama imkanlarının sınırlı olduğu, verimsiz ve çorak arazilerin bulunduğu veya mısır silajı üretim maliyetlerinin yüksek olduğu bölgelerde, mısır silajına umut verici bir alternatif olarak kullanılabileceği ileri sürülebilir.

Anahtar kelimeler: Alternatif yemler, Konsantre yemler, Besi performansı, Kaba yem, Kıvırcık, Silaj.

The Effects of Maize Silage and Sunflower Silage and Their Mixtures at Different Levels on the Fattening Performance of Kıvırcık Lambs

ABSTRACT

Maize silage is a forage source widely used in the feeding of ruminant animals worldwide. However, maize is an expensive and difficult product to grow in cold and dry climates. This situation is one of the factors that negatively affects the widespread use of silage in our country. For this reason, the issue of silage production from alternative plants has been brought to the agenda for regions where corn silage production is not economical. One of the silage plants in question is sunflower, which can be grown in cold and arid climates. This study aimed to investigate the effects of corn and sunflower silage and their mixtures in different proportions on the fattening performance of lambs. In the study, 40 Kıvırcık male lambs, aged 2.5-3 months

and with an average live weight of 23-25 kg, were used as animal material. The experiment was carried out in a semi-open barn for 56 days. According to the experimental design, the animals were divided into 5 different silage groups (100 maize silage, 75% maize silage+25% sunflower silage, 50% maize silage+50% sunflower silage, 25% maize silage+75% sunflower silage, 100% sunflower silage) and each group contained 8 lambs. The lambs were housed in individual pens and fed individually throughout the experiment. Silages were given ad libitum and additionally 700, 900 and 1400 g of concentrate feed were given daily between days 0-21, 22-42 and 43-56, respectively. During the fattening period, live weight, daily live weight gain, feed consumption and feed conversion ratio values were determined. The differences between the live weight values of different silage groups during the experiment were not found to be significant and the values obtained at the end of 8 weeks varied between 35.9 and 37.4 kg. Silage consumption of lambs fed with different silage types showed significant differences at 0-2 and 6-8 weeks ($p<0.05$). As a result, it was determined that substituting up to 100% of maize silage with sunflower silage in lamb fattening did not have any negative effect on fattening performance. Considering both fattening performance and consumption levels, it can be suggested that sunflower silage can be used as a promising alternative to maize silage, especially in regions where winter conditions are harsh, irrigation opportunities are limited, barren and unproductive lands are present or maize silage production costs are high.

Key words: Alternative feeds, Concentrated feeds, Fattening performance, Forage, Kıvırcık, Silage.

INTRODUCTION

Approximately 70% of the costs of livestock enterprises are roughage and concentrated feed (Kara and Eroğlu, 2018). This shows how effective and decisive feed is in the development of livestock. Today, where the demand for animal products is increasing, more and more roughage and intensive feed production is needed for more animal food production. To obtain high yield from animals, it is necessary to meet their nutritional needs at a balanced and sufficient level. For this purpose, it is necessary to use quality roughage and concentrated feed sources (Kutlu, 2016). In this context, one of the quality and inexpensive roughage sources that can be used in feeding ruminants instead of expensive concentrated feed is silage.

Adding silage to the rations of animals with concentrated feel can allow breeders to achieve both economical and rational advantages in feeding. In addition to their quality, silo feeds are a very attractive because they ensure winter nutrition, maintain their freshness for a long time, minimize storage losses, and are not affected by unfavorable weather conditions.

Among the forage crops cultivated for silage production, cereals such as maize, wheat, and sorghum, which have high water-soluble carbohydrate contents and low buffer capacity, come to the fore, but maize silage constitutes more than 80% of the total silage in general production (Yaylak and Alçiçek, 2003). The reason why maize is the most preferred plant material for silage production is its high dry matter content, low buffer capacity, and sufficient amount of water-soluble carbohydrates, which are essential for lactic acid fermentation. However, since maize silage alone cannot adequately meet the nutritional requirements of animals, it needs to be supplemented in terms of protein, energy, vitamins, and minerals (Filya, 2001; Filya, 2007; Özen et al., 2016).

Nevertheless, some regions at high altitudes, low temperatures, and with short development periods are not suitable for the cultivation of maize, which is a hot climate plant. For this reason, silage plants that can be an alternative to maize silage in terms of the sustainability and continuity of silage production are being examined in various studies (Nolan, 1974; Stanley, 2003). One of the plants that can be an alternative to maize in silage production is sunflower, which is an annual industrial plant. Although sunflower is grown for different purposes (e.g., oil, pulp, snacks) in the world, it is also grown as a silage plant in some countries. Sunflower cultivation is easier than maize, and it can be an alternative, especially in regions that do not receive much precipitation, and when irrigation systems are limited. It is possible to benefit from sunflower thanks to its higher tolerance to high and low temperatures than maize and its high adaptability to various soil conditions (Yıldız, 2017). In high altitude regions, sunflower silage can be an important alternative roughage source to meet the roughage needs of cattle and sheep.

Although sunflower silage does not find much production and use globally, it is currently used in a few countries such as the United States and Canada. As a matter of fact, in regions of the United States such as Montana, which has a high altitude in the north, the use of sunflower as a silage material is higher than that of maize. In some South American countries, sunflower varieties for silage-making have been developed for use in animal nutrition (Tomich et al., 2003; Velázquez-Martínez et al., 2022).

The use of silage in the feeding of small ruminants is not very common. Due to its nutritional value and low production cost, it can be a suitable feed source for feeding sheep and goats. The rations of small ruminants largely consist of roughage, so silages produced from these can be consumed by animals. De Vyver et al. (2014) reported that silage can be used successfully for fattening lambs. The recommended silage consumption amounts for sheep are between 1 kg for breeding sheep and 0.5-1.3 kg for fattening lambs per day. It has been reported that sheep can be given up to 5 kilograms of silage per animal per day.

Therefore, the aim of the present study was to determine the effects of feeding maize and sunflower silage, alone or in combination, together with concentrated feed, on the fattening performance of lambs and especially the possibilities of using sunflower silage in lamb fattening.

MATERIAL AND METHODS

2.1 Animals and location

This study was carried out with a total of 40 Kıvırcık lambs, divided into 5 groups of 8 in a semi-open barn in a sheep farm belonging to the Agricultural Application and Research Center of Bursa Uludağ University (Bursa Uludağ Üniversitesi Tarımsal Uygulama ve Araştırma Merkezi) during the April-June period. The fattened lambs were housed in individual compartments during the 56-day trial period and fed individually.

2.2. Feeding program and treatments

The silage used in the study was obtained from sunflower planted in a field belonging to the Agricultural Application and Research Center of Bursa Uludağ University. The harvest was carried out during the filling of the grains and the dropping of the yellow leaves (28% dry matter). The maize silage used in the experiment was obtained from a private company. Maize was cultivated in the same period as the sunflower used in the experiment and was ensiled with the same method.

The 40 lambs at the ages of 2.5-3 months with average live weights between 23 and 25 kg that were included in the experiment were divided into 5 different silage groups, and each group was fed *ad libitum* with its own silage formulation. The silage groups were designed to include 100% maize silage, 75% maize silage+25% sunflower silage, 50% maize silage+50% sunflower silage, 25% maize silage+75% sunflower silage, and 100% sunflower silage.

In the experiment, a mixture of barley, maize, sunflower seed meal, dicalcium phosphate (DCP), salt, and minerals-vitamins was used in the preparation of the concentrated feed used in lamb rations. The contents of the concentrated feed are given in Table 1.

Table 1. Composition of the concentrated feed used in the experiment.

Raw materials	**Ratio (%)**
Barley	50.3
Maize	20.0
Sunflower seed meal	27.0
Dicalcium phosphate (DCP)	1.5
Salt	1.0
Mineral-vitamin mixture*	0.2
Total	100.0

*Per kg: Vit. A 300,000 IU; Vit. D_3 50,000 IU; Vit. E 1,250 mg; manganese (oxide) 3,000 mg; iron (sulphate) 3,000 mg; zinc (oxide) 4,500 mg; copper (sulphate) 1,000 mg; cobalt (mono carbonate) 30 mg; iodine (calcium iodate) 45 mg; selenium (sodium selenite) 12 mg; filler (razmol or $CaCO_3$) 969,066 mg.

In addition to the silage mixtures given to the lambs, 700 g of concentrated feed per animal was given in the first 4 weeks of the experiment. Later, this amount was increased to 900 g for 4 weeks and to 1,400 g in the last 2 weeks of the experiment, considering the daily nutrient needs of the animals.

The results of the analyses performed to determine the nutrient composition of maize silage, sunflower silage and concentrated feed used in the treatment are given in Table 2.

The lambs were fed once a day at 09:00 in the morning. The remaining feeds from the feeders in the individual compartments were collected and weighed daily before a new batch of feed was prepared the next day, and the amount of silage mixture and concentrated feed consumed by each animal per day was determined. The silage mixtures to be given to the lambs were prepared and given daily just before the time of feeding. Fresh and clean drinking water was made constantly available.

During the trial period, the live weights and feed consumption of lambs were determined individually. Animals housed in individual chambers were weighed on an empty stomach at 9:00 am with a 100 g precision scale, once every 14 days, by taking the food and water in front of them the night before. The feed

consumption of the lambs was determined by subtracting the left-over from the total feed given to the animals the previous day. During the fattening period, the average temperature in the barn was 23 °C, and the humidity was 57%.

Table 2. Nutrient composition of maize silage, sunflower silage, and concentrated feed used in the experiment.

Nutrients	Maize silage (%)	Sunflower silage (%)	Concentrated feed (%)
Dry matter	29.61	25.62	87.57
Organic matter	95.11	87.73	93.61
Crude fat	2.14	9.70	1.17
Crude cellulose	19.03	26.40	8.30
Crude ash	4.89	12.27	6.39
Cellulose	25.74	32.65	3.94
Hemicellulose	16.20	7.69	8.97
Nitrogen-free core substances	20.12	12.24	69.07
NDF	42.99	46.69	14.13
ADF	26.79	39.00	5.16
ADL	1.05	6.35	1.22
pH	3.76	4.07	-
Crude protein	8.00	9.75	15.07
ME (kcal/kg DM)	2444	2179	2826

NDF: Neutral Detergent Fiber, ADF: Acid Detergent Fiber, ADL: Acid Detergent Lignin, ME: Metabolic Energy, DM: Dry Matter.

The feed ingredients and diets used in the experiment were ground using a laboratory mill (IKA A 10, Istanbul, Turkey) with a 1 mm sieve and prepared for chemical analyses. To determine the dry matter (DM) content of the feed samples, the samples were dried in an oven (Nüve N120, Ankara, Turkey) at 105 °C for 3 hours, and the ash content was determined by ashing the samples in a muffle furnace (Nüve FN500, Ankara, Turkey) at 550 °C for 4 hours. The nitrogen (N) content was determined using the Kjeldahl method (Gerhardt Kjeldatherm-Vap30, Königswinter, Germany) and the crude fat content was determined by ether extraction according to the methods described in AOAC (1990). The metabolic energy values of feed raw materials, rations, and silages were calculated with the formula specified by TSE 1991. The neutral detergent fiber (NDF), acid detergent fiber (ADF), and acid detergent lignin (ADL) contents, which are components of the cell wall of feed ingredients and experimental diets, were determined according to the methods described by Van Soest and Robertson (1980). The levels of cellulose (ADF-ADL) and hemicellulose (NDF-ADF) were calculated (Ankom Fiber Analyzer 200, Macedon, NY, USA). The feed conversion ratio was calculated by dividing feed consumption per period by live weight gain in the same period.

2.3. Statistical analysis

Data were analyzed using one-way analysis of variance employing the SPSS 23.0 package program. Duncan's Multiple Comparisons Test was used to determine the significance level of the differences between mean values. The level of statistical significance was accepted as $p \leq 0.05$.

The statistical model applied in the study was

$$y_{ijk} = \mu + a_i + b_j + e_{ijk}$$

Where:

Y_{ijk} = measurement of a particular trait,

μ = the population mean,

a_i = effect of groups,

b_j = effect of weeks,

e_{ijk} = random error.

RESULTS AND DISCUSSION

The live weight values of the lambs fed maize silage, sunflower silage, or different mixtures of these at different periods are shown in Table 3. The differences among the live weight values of the silage groups during the trial period were found to be not significant ($p>0.05$), and the values obtained at the end of 8 weeks varied between 35.9 and 37.4 kg.

Table 3. Mean live weight and standard error values of lambs.

Weeks	Silage types and ratios					p-value
	100% Maize	75% Maize+25% Sunflower	50% Maize+50% Sunflower	25% Maize+75% Sunflower	100% Sunflower	
			Live weight (kg)			
0	24.3±1.0	24.2±0.9	25.1±1.1	24.4±1.0	23.7±1.0	NS
2	25.6±0.9	25.5±0.7	27.3±1.0	25.7±1.0	25.2±1.1	NS
4	29.7±0.9	30.0±0.8	30.3±1.4	29.0±0.9	29.5±1.1	NS
6	33.8±0.9	34.1±0.8	34.1±1.3	32.5±0.9	33.1±1.0	NS
8	37.4±0.8	37.4±0.8	37.4±1.4	35.9±0.9	36.3±1.0	NS

Differences between means within the same row are not significant. NS: Non-significant.

Table 4 shows the mean values of the average daily weight gains of the lambs in different periods. The differences among the daily average body weight gains of the lambs in the experimental groups at 0-2 and 2-4 weeks were significant ($p<0.05$). The highest average daily gain values were seen in the 50% maize silage+50% sunflower silage group in the period of 0-2 weeks and in the 75% maize silage+25% sunflower silage group in the period of 2-4 weeks. In the other periods of the experiment, the differences among the average daily weight gain values disappeared, and the groups had similar values. Considering the entire experiment period, feeding the lambs with different silage types during the 0-8-week period did not have a significant effect on their average daily weight gain.

Table 4. Mean and standard error values of the average daily weight gain of lambs fed maize silage, sunflower silage, or their mixtures at different ratios.

Weeks	Silage types and ratios					p-value
	100% Maize	75% Maize+25% Sunflower	50% Maize+50% Sunflower	25% Maize+75% Sunflower	100% Sunflower	
			Average daily gain (g/day)			
0-2	$93.8±11.6^{b}$	$89.3±15.6^{b}$	$153.6±13.3^{a}$	$89.3±9.2^{b}$	$112.5±20.5^{ab}$	<0.05
2-4	$293.8±19.7^{abc}$	$320.5±19.0^{a}$	$219.6±44.2^{c}$	$234.8±17.4^{bc}$	$307.2±17.9^{ab}$	<0.05
4-6	288.4±16.5	292.0±18.8	268.8±22.4	250.9±11.0	256.3±21.3	NS
6-8	263.4±10.2	236.6±10.9	234.8±12.5	248.2±26.6	224.1±15.9	NS
0-8	234.8±6.7	234.6±9.0	219.2±11.1	205.8±8.3	225.0±7.4	NS

Different superscript letters ($^{a, b, c}$) within the same row indicate significant differences between means. NS: Non-significant.

The live weight gain values of the lambs in the experimental groups in in different periods are given in Table 5.

Table 5. Mean and standard error values of the live weight gain of the lambs fed maize silage, sunflower silage, or their mixtures at different ratios.

Weeks	Silage types and ratios					p-value
	100% Maize	75% Maize+25% Sunflower	50% Maize+50% Sunflower	25% Maize+75% Sunflower	100% Sunflower	
	Live weight gain (kg)					
0-2	1.3±0.2^{b}	1.3±0.2^{b}	2.2±0.2^{a}	1.3±0.1^{b}	1.6±0.3^{ab}	<0.05
2-4	4.1±0.3^{abc}	4.5±0.3^{a}	3.1±0.6^{c}	3.3±0.2^{bc}	4.3±0.3^{ab}	<0.05
4-6	4.0±0.2	4.1±0.3	3.8±0.3	3.5±0.2	3.6±0.3	NS
6-8	3.7±0.1	3.3±0.2	3.3±0.2	3.5±0.4	3.1±0.2	NS
0-8	13.2±0.4	13.1±0.5	12.3±0.6	11.5±0.5	12.6±0.4	NS

Different superscript letters ($^{a, b, c}$) within the same row indicate significant differences between means. NS: Non-significant.

The differences among the live weight gain values of the experimental groups were significant ($p<0.05$) at 0-2 and 2-4 weeks, while they were not significant at 4-6 and 6-8 weeks. While the group given 50% maize silage+50% sunflower silage had the highest amount of live weight gain in the first 2 weeks, the group given 75% maize silage+25% sunflower silage performed better in the period of 2-4 weeks. Considering the 0-8-week period, it was observed that the silage types did not have a significant effect on the live weight gain values of the lambs.

The mean values of the average daily silage intake of the lambs in different periods are given in Table 6.

Table 6. Mean and standard error values of the daily silage intake of the lambs fed maize silage, sunflower silage, or their mixtures at different ratios.

Weeks	Silage types and ratios					P-value
	100% Maize	75% Maize+25% Sunflower	50% Maize+50% Sunflower	25% Maize+75% Sunflower	100% Sunflower	
	***Average daily* silage intake (kg)**					
0-2	0.8±0.1^{b}	0.8±0.1^{ab}	1.1±0.2^{ab}	0.8±0.1^{b}	1.2±0.2^{a}	<0.05
2-4	0.9±0.1	0.9±0.1	1.2±0.3	1.0±0.1	1.5±0.3	NS
4-6	0.8±0.1	0.8±0.1	1.1±0.3	1.0±0.1	1.2±0.2	NS
6-8	1.0±0.1^{b}	1.1±0.1^{a}	1.4±0.2^{a}	1.4±0.1^{a}	1.5±0.1^{a}	<0.05
0-8	0.9±0.1	0.9±0.1	1.2±0.2	1.0±0.1	1.4±0.2	NS

Different superscript letters ($^{a, b, c}$) within the same row indicate significant differences between means. NS: Non-significant.

While the average daily silage intake of the lambs in different experimental groups showed significant differences ($p<0.05$) at-2 weeks and 6-8 weeks, similar results were obtained in the other periods and the entire fattening period (0-8 weeks). The group with the highest daily silage consumption in the periods of 0-2 and 6-8 weeks was the 100% sunflower silage group. The 100% maize silage group consumed the lowest amount of silage in both periods. One of the groups that consumed the lowest amounts of silage in the first two weeks was the 25% maize silage+75% sunflower silage group. Considering the entire fattening period, it is seen that there was no significant difference among the daily amounts of silage consumed by the lambs in the experimental groups.

The of silage consumption values of the lambs in different periods are given in Table 7.

Table 7. Mean and standard error values of the silage intake of the lambs fed maize silage, sunflower silage, or their mixtures at different ratios.

Weeks	Silage types and ratios					p-value
	100% Maize	75% Maize+25% Sunflower	50% Maize+50% Sunflower	25% Maize+75% Sunflower	100% Sunflower	
	Silage intake (kg)					
0-2	10.7±1.2^{b}	11.7±1.0^{ab}	15.4±2.1^{ab}	10.6±1.4^{b}	16.6±2.4^{a}	<0.05
2-4	12.4±1.1	12.4±1.0	16.0±3.5	14.2±0.9	21.0±3.5	NS
4-6	11.4±0.8	11.0±1.2	15.5±3.5	13.8±0.9	17.4±2.9	NS
6-8	14.2±1.1^{b}	14.6±1.1^{b}	20.1±3.1^{a}	19.9±0.9^{a}	21.5±1.9^{a}	<0.05
0-8	48.6±3.8	49.7±3.4	67.0±11.7	58.4±3.4	76.4±10.2	NS

Different superscript letters ($^{a, b, c}$) within the same row indicate significant differences between means. NS: Non-significant.

The silage consumption values of the lambs showed significant differences among the groups ($p<0.05$) at 0-2 and 6-8 weeks. The differences among the silage consumption values of the groups were not found significant ($p>0.05$) in the other periods or in the entire fattening period. The group that consumed the highest amount of silage in the periods of 0-2 and 6-8 week was the 100% sunflower silage group. While the groups that consumed the least silage in the first 2 weeks of the experiment were the 100% maize silage and the 25% maize silage+75% sunflower silage groups, in the period of 6-8 week, the groups with the lowest consumption values were those given 100% maize silage and 75% maize silage + 25% sunflower silage. There were no significant differences among the total silage consumption values of the groups during the entire 0-8-week fattening period.

The of average daily concentrated feed intake values of the lambs in different periods are given in Table 8.

Table 8. Mean and standard error values of the average daily concentrated feed intake of the lambs fed with maize silage, sunflower silage, or their mixtures at different ratios.

Weeks	Silage types and ratios					P-value
	100% Maize	75% Maize+25% Sunflower	50% Maize+50% Sunflower	25% Maize+75% Sunflower	100% Sunflower	
	Average daily concentrated feed intake (kg)					
0-2	0.7±0.0	0.7±0.0	0.7±0.0	0.7±0.0	0.7±0.0	NS
2-4	0.8±0.0	0.8±0.0	0.8±0.0	0.8±0.0	0.8±0.0	NS
4-6	0.8±0.0	0.9±0.0	0.9±0.0	0.9±0.0	0.9±0.0	NS
6-8	1.4±0.0	1.4±0.0	1.4±0.0	1.4±0.0	1.4±0.0	NS
0-8	1.0±0.0	0.9±0.0	0.9±0.0	0.9±0.0	0.9±0.0	NS

Different superscript letters ($^{a, b, c}$) within the same row indicate significant differences between means. NS: Non-significant.

The differences among the daily average concentrated feed consumption values of the experimental groups were not significant ($p>0.05$) for any single periods or the entire fattening period. While the lambs were

being fed, they started to consume silage after eating concentrated feed first. No significant difference (p>0.05) was observed among the concentrated feed consumption values of the groups. During the fattening period, all groups consumed an average of 0.9 kg of concentrated feed per day.

The concentrated feed intake values of the lambs in different periods are given in Table 9.

Table 9. Mean and standard error values of the concentrated feed intake of the lambs fed maize silage, sunflower silage, or their mixtures at different ratios.

Weeks	Silage types and ratios					p-value
	100% Maize	75% Maize+25% Sunflower	50% Maize+50% Sunflower	25% Maize+75% Sunflower	100% Sunflower	
	Concentrated feed intake (kg)					
0-2	9.2±0.2	9.4±0.0	9.4±0.1	9.1±0.2	9.4±0.0	NS
2-4	10.6±0.2	10.7±0.0	10.7±0.2	10.7±0.1	10.7±0.1	NS
4-6	11.8±0.3	12.2±0.0	12.0±0.2	12.1±0.1	12.2±0.0	NS
6-8	19.2±0.1	19.5±0.0	19.4±0.1	19.3±0.2	19.5±0.1	NS
0-8	50.8±0.7	51.9±0.1	51.4±0.4	51.2±0.4	51.8±0.1	NS

Different superscript letters ($^{a, b, c}$) within the same row indicate significant differences between means. NS: Non-significant.

The average daily silage + concentrated feed intake values of the lambs in different periods are given in Table 10.

The differences among the mean daily silage + concentrated feed intake of the lambs fed different silage formulations were significant (p<0.05) in the periods of 0-2, 6-8, and 0-8 weeks. In the first two weeks of the experiment, the 100% sunflower silage group consumed the most daily silage + concentrated feed, while the lowest consumption was found in the 25% maize+75% sunflower silage and 100% maize silage groups. In the 6-8-week period, the 100% sunflower silage and 50% maize silage+50% sunflower silage groups had the highest daily intake of silage + concentrated feed. The lowest value of consumption was in the 100% maize silage group. Considering the 0-8 week fattening period as a whole, it was observed that the silage + concentrated feed intake in different silage groups showed significant differences (p<0.05).

Table 10. Mean and standard error values of the daily silage + concentrated feed intake of the lambs fed maize silage, sunflower silage, or their mixtures at different ratios.

Weeks	Silage types and ratios					p-value
	100% Maize	75% Maize+25% Sunflower	50% Maize+50% Sunflower	25% Maize+75% Sunflower	100% Sunflower	
	Average daily silage + concentrated feed intake (kg)					
0-2	1.4±0.1^{b}	1.5±0.1^{ab}	1.8±0.2^{ab}	1.4±0.1^{b}	1.9±0.2^{a}	<0.05
2-4	1.6±0.1	1.7±0.1	1.9±0.2	1.8±0.1	2.3±0.3	NS
4-6	1.7±0.1	1.7±0.1	2.0±0.2	1.9±0.1	2.1±0.2	NS
6-8	2.4±0.1^{c}	2.4±0.1^{bc}	2.8±0.2^{a}	2.8±0.1^{ab}	2.9±0.1^{a}	<0.05
0-8	1.8±0.1^{b}	1.1±0.1^{b}	2.1±0.2^{ab}	2.0±0.1^{ab}	2.3±0.2^{a}	<0.05

Different superscript letters ($^{a, b, c}$) within the same row indicate significant differences between means. NS: Non-significant.

The total silage + concentrated feed intake values of the lambs belonging to different experimental groups in different periods are given in Table 11.

Table 11. Mean and standard error values of the silage + concentrated feed intake of the lambs fed maize silage, sunflower silage, or their mixtures at different ratios.

Weeks	Silage types and ratios					p-value
	100% Maize	75% Maize+25% Sunflower	50% Maize+50% Sunflower	25% Maize+75% Sunflower	100% Sunflower	
	Silage + concentrated feed intake (kg)					
0-2	19.9±1.3^{b}	21.1±1.0^{ab}	24.7±2.0^{ab}	19.7±1.5^{b}	26.1±2.4^{a}	<0.05
2-4	22.9±1.1	23.2±2.0	26.7±3.4	24.9±0.9	31.7±3.6	NS
4-6	23.2±0.9	23.2±1.9	27.5±3.4	25.9±0.9	29.6±2.9	NS
6-8	33.4±1.1^{c}	34.2±1.1^{bc}	39.5±3.0^{a}	39.2±0.9^{ab}	40.9±1.8^{a}	<0.05
0-8	99.3±4.0^{b}	101.6±3.4^{b}	118.5±11.4^{ab}	109.7±3.5^{ab}	128.2±10.2^{a}	<0.05

Different superscript letters ($^{a, b, c}$) within the same row indicate significant differences between means. NS: Non-significant.

The differences among the mean total silage + concentrated feed intake values of the groups were significant ($p<0.05$) in the periods of 0-2, 6-8, and 0-8 weeks. In the 0-2-week period, the group that consumed the highest amount of silage + concentrated feed was the 100% sunflower silage group. In the same period, the groups with the lowest amounts of consumption were the 100% maize silage group and the 25% maize silage+75% sunflower silage group. In the 6-8-week period, the groups with the highest consumption values were the 100% sunflower silage group and the 50% maize silage+50% sunflower silage group. In the mentioned period, the minimum consumption values were realized in the 100% maize silage group and the 75% maize silage+25% sunflower silage group. It was determined that silage types were effective on silage + concentrated feed intake in the overall 8-week period.

The values related to the feed conversion ratios of the lambs belonging to different experimental groups in different periods are given in Table 12.

Table 12. Mean and standard error values of the feed conversion ratios of the lambs fed maize silage, sunflower silage, or their mixtures at different ratios.

Weeks	Silage types and ratios					p-value
	100% Maize	75% Maize+25% Sunflower	50% Maize+50% Sunflower	25% Maize+75% Sunflower	100% Sunflower	
	Feed conversion ratio (kg:kg)					
0-2	17.2±2.6	24.7±7.8	12.4±1.8	18.8±4.4	19.6±3.6	NS
2-4	5.7±0.4^{b}	5.2±0.1^{b}	10.0±1.1^{a}	8.0±0.8^{ab}	7.5±0.9^{ab}	<0.01
4-6	5.8±0.3^{b}	5.8±0.4^{b}	7.8±1.3^{ab}	7.4±0.3^{ab}	8.6±0.9^{a}	<0.05
6-8	9.2±0.6^{b}	10.4±0.3^{b}	12.1±0.9^{ab}	12.4±1.5^{ab}	13.6±1.3^{a}	<0.05
0-8	7.6±0.4^{b}	7.8±0.2^{b}	9.6±0.7^{ab}	9.7±0.6^{ab}	10.2±0.8^{a}	<0.01

Different superscript letters ($^{a, b, c}$) within the same row indicate significant differences between means. NS: Non-significant.

Table 12 shows that the differences among the mean feed conversion ratio values of the groups were significant ($p<0.01$, $p<0.05$), except for the 0-2-week period. In the 2-4-week period, it was determined that the 100% maize silage group and the 75% maize silage+25% sunflower silage group were the groups that benefited from the feed best ($p<0.01$). In this period, the lowest feed conversion ratio was observed in the 50% maize silage+50% sunflower silage group. It was determined that the 100% maize silage group and the 75% maize silage+25% sunflower silage group benefited from the feed best in the periods of 4-6 and 6-8 weeks, as in the first two weeks ($p<0.05$). The aforementioned groups had significantly better feed conversion ratios compared to the 100% sunflower silage group in these periods. In the 0-8 weeks of fattening, the 100% maize silage group and the 75% maize silage+25% sunflower silage group were again the groups that benefited from the feed best. These groups benefited from the feed to a significantly greater extent ($p<0.01$) than the 100% sunflower silage group. As a result, a significant improvement in feed efficiency was observed due to the increase in maize silage in the diet of the animals.

In this study, significant differences were observed among the groups formed with Kıvırcık lambs fed maize silage, sunflower silage, or their mixtures prepared at different ratios in terms of their daily silage + concentrated feed intake, silage + concentrated feed intake during the fattening period, and feed conversion ratios. In previous studies on this subject, different results have been reported regarding the effects of feeding with different silages. Malisetty *et al*. (2013) reported that the use of different ratios of silage in lamb rations significantly affected the weights of the animals at the end of fattening, while Keleş *et al*. (2018) reported that feeding with different silages was not effective on weight at the end of fattening. Fluharty *et al*. (2017) stated that in lamb fattening, maize silage was 21.2% more effective on weight at the end of fattening compared to alfalfa straw feeding. As for average daily weight gain, De Sousa et al. (2008), in their study on lamb fattening with silage, reported 107 g/day in the group fed with sunflower and 104 g/day in the group fed with maize silage, and they obtained different results from ours. Azambuja Ribeiro *et al.* (2002) found that lambs consuming sunflower silage had higher daily weight gain values than those consuming maize and sorghum silages. The researchers attributed this result to the higher consumption rates of sunflower silage by the animals. Bueno *et al.* (2004) revealed that maize silage provided higher daily live weight gain in lambs compared to sunflower silage. The reason why the values reported by both researchers were different from the data obtained in the current study was considered to be the high amount of concentrated feed we used and the fact that most of the energy need of the animals was met by the concentrated feed and therefore, the effects of the silages were reduced. Almeida Junior *et al.* (2004) explained in a similar study using maize silage that the moisture content of the silage did not affect average daily weight gain outcomes. Regarding live weight gain values, similar results were reported by De Sousa *et al.* (2008), who fed lambs sunflower and maize silages. Nolan (1974), who fed lambs clover+grass silage, also obtained similar results in terms of other performance parameters like live weight and feed efficiency. Considering the fattening period of 0-8 weeks in the present study, it was determined that the silage intake of the lambs rose along with the increase in the sunflower silage ratio in their rations. Nolan (1974) explained that feeding lambs only silage or adding concentrated feed in addition to silage affected their average daily silage intake. Stanley (2003) reported that quality silage can provide the desired average daily weight gain in lambs. Anil *et al.* (2000), contrary to the data we obtained, demonstrated that consumption was similar in lambs fed different types of silages. Although the increase in the ratio of sunflower silage in the rations of the lambs included in this study did not lead to a significant difference in the concentrated feed intake values of the animals, it can be stated that it increased their dry matter intake because it raised their silage intake. In addition to this, an increase in the silage intake of the animals was observed with an increase in the sunflower silage ratio in their rations. Considering the eight-week fattening period, it was determined that feed efficiency improved depending on the increase in the ratio of maize silage in the ration, while it decreased with the increase in the ratio of sunflower silage in the ration. The feed conversion ratio results obtained by Azambuja Ribeiro *et al.* (2002) and Bueno *et al.* (2004) were similar to those obtained in this study. Malisetty *et al.* (2013) observed that feed conversion ratios were higher in lambs fed maize silage. The consumption of more sunflower silage by the lambs in their rations indicated that they consumed this silage with pleasure. However, although sunflower silage was consumed more by the lambs, these lambs performed similarly to the lambs consuming maize silage. This result was attributed to the sunflower silage having lower metabolic energy and higher ADF and ADL values than the maize silage.

CONCLUSION

As a result, it was determined that the substitution of maize silage up to 100% by sunflower silage in the process of lamb fattening did not have any negative effect on fattening performance. Keeping in mind both fattening performance and consumption levels, it can be argued that sunflower silage can be used as a promising alternative to maize silage, especially in regions where winter conditions are harsh, irrigation facilities are limited, there are barren and inefficient lands, or the cost of maize silage production is high. Positive results were obtained in terms of the use of sunflower silage in lamb fattening, and it may be recommended to conduct similar studies in dairy and beef cattle where silage consumption rates are higher.. Additionally, it was concluded that it would be useful to consider mixtures of sunflower silage with silages other than maize silage (e.g., clover, wheat, sorghum, grass) in different studies.

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