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The Forage Yield and Silage Quality of Maize-Sorghum-Sainfoin Mixtures

Mısır-Sorghum-Korunga Karışımlarının Ot Verimi ve Silaj Kalitesi

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THE FORAGE YIELD AND SILAGE QUALITY OF MAIZE-SORGHUM-SAINFOIN MIXTURES

ABSTRACT

The aim of the study was to determine forage yield and silage quality in maize/sorghum (M/S) with sainfoin (SA). The field trial was conducted in 2022 to study the effects of different binary sowing ratios (80%M-20%SA, 60%M-40%SA, 30%M-70%SA; 80%S-20%SA, 60%S-40%SA, 30%S-70%SA, 100%M, 100%SA, 100%S) in 3 replications. Prior to ensiling, the hay yield and fresh yield in the intercropping plots were measured. Parameters of dry matter ratio, pH, crude protein, ADF, NDF, mineral matters, and organic acid were defined in silages opened after fermentation. Before ensiling the highest yield was obtained from maize and yield decreased with an increase in sainfoin sowing density. After ensiling, all of the silage parameters were affected by mixing ratios. When the sainfoin ratio was decreased, dry matter, crude protein, and pH of mixture silages were dramatically reduced, but mineral matters were increased. The highest dry matter was determined in sole sainfoin silage. The best results of lactic acid and acetic acid contents were defined in 80%S-20%SA and 60%S-40%SA silage (except for sole treatments). Besides, it was seen that the addition of sorghum to sainfoin silage increases lactic acid content compared to maize. As a result, intercropping of sainfoin with maize and sorghum provided profitable feed production and improved silage quality. As a result, intercropping of sainfoin with maize and sorghum provided profitable feed production and improved silage quality.

Keywords: Fermentation, Forage Yield, Intercropping, Organic Acid, Protein.

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MISIR-SORGHUM-KORUNGA KARIŞIMLARININ OT VERİMİ VE SİLAJ KALİTESİ

ÖZ

Bu çalışmada korunga (K) ile mısır ve sorgum (M/S) yalın ve karışık ekimlerinin ot verimi ve silaj kalitelerinin belirlenmesi amaçlanmıştır. Deneme 2022 yılında 3 tekrar ve ikili karışım oranlarında (%80M-%20K %60M-%40K, %30M-%70K; %80S-%20K, %60S-%40K, %30S-%70K, %100M, %100K, %100S) yürütülmüştür yapılmıştır. İşlemlerin silolama öncesi kuru ot verimi ile yeşil ot verimleri belirlenmiştir. Fermantasyon sonrası açılan silajlarda kuru madde oranı, pH, ham protein, ADF, NDF, mineral maddeler, organik asit parametreleri belirlenmiştir. En yüksek verim silolama öncesi mısırdan elde edilmiş olup, korunga oranının artmasıyla verim azalmıştır. Silolama sonrasında tüm silaj parametreleri karışım oranlarından etkilenmiştir. Korunga oranı azalmasıyla karışım silajlarının kuru maddesi ve pH'ı önemli ölçüde azalırken, ham protein ve mineral maddeleri ise artmıştır. En yüksek kuru madde oranı yalın korunga silajında belirlenmiştir. En yüksek laktik asit ve asetik asit içerikleri sırasıyla %80S-%20K ve %60S-%40K silajlarında belirlenmiştir. Ayrıca korunga silajına sorgum ilavesi mısıra göre laktik asit içeriğini arttırmıştır. Sonuç olarak korunga ile mısır ve sorgum karışık ekimi karlı yem üretimi sağlarken, silaj kalitesini de iyileştirmiştir.

Anahtar Kelimeler: Fermantasyon, Ot Verimi, Karışık Ekim, Organik Asit, Protein.

1. INTRODUCTION

With the increasing population in developing countries, the problem of food shortage is very important. The amount and quality of protein, which is the basis of healthy nutrition, plays a key role in solving the problem of food shortage. To be cheap, accessible and increasing animal products that provide quality proteins can be possible with the development of animal husbandry. The development of livestock enterprises in Turkey is related to the affordability of the animal forage supply, which constitutes a large part of the cost. In this context, one of the most important and valuable natural resources that can play a vital role in meeting the needs of people in terms of animal protein is rangelands. However, the yield of rangelands in Turkey is quite low due to natural and human factors. For this reason, it is necessary to increase forage production in various ways (Afshar et al. 2014).

In this context, Sainfoin (*Onobrychis sativa* Scop.) is one of the most important legume forage crops favored by animals due to its high taste and nutritional value (Delgado et al., 2008). Sainfoin has been cultivated for hundreds of years in many parts of the world, including Asia, Europe, North America, and Turkey. However, the share of sainfoin in forage crop cultivation has decreased in Turkey in recent years. The sainfoin to Turkey origin has many features such as a large root surface, the ability to tolerate drought and severe weather conditions, the ability to grow in poor soils, abundant availability in natural rangelands, the ability in nitrogen fixation, and generally need very little fertilizer and maintenance. It also has the potential to increase protein utilization and reduce greenhouse gas emissions due to its unique tannin and polyphenol composition. However, sainfoin is not preferred by farmers because it is difficult to harvest, its regrowth is very slow, and its yield decreases from year to year. Therefore, the use of sainfoin in mixed cropping systems and for silage purposes presents an alternative for assessing a quality forage source.

It has been known from the past that the grass and legume mixed cropping system is more advantageous than pure sowing and provides the best use of the unit area (Lu et al., 2000; Li et al., 2022). Because intercropping makes better use of light, water, and food sources while also inhibiting weed development, it produces a higher yield per acre than mono-cropping. (Rad et al., 2020; Eichler-Löbermann et al., 2021). Akdeniz (2019) and Dubbs (1971) reported that sainfoin was used in this system to increase yield and quality. In the study, the general reason for sowing intercropping to sainfoin, a high-quality perennial forage plant, is to obtain economic products in the planting year, to form rapid soil cover, and to combat weeds. In detail, since biomass yield is high and silage is the aim, companion plants that will form high-quality silage were selected. For thousands of years, forages have been preserved by ensiling raw plant material via silage, a fundamental biological preservation technique based on spontaneous lactic acid fermentation under anaerobic conditions. Silage production is important in countries where winters are harsh and animals cannot obtain the energy or nutrients they need throughout the year without grazing, especially in Turkey. Epiphytic lactic acid bacteria use simple carbohydrates found in silage plants and metabolize them to lactic acid inhibiting the formation of acetic acid, preventing the deterioration of the silage, and allowing it to be stored for a long time. Thus, cereals such as maize and sorghum, which have higher amounts of water-soluble carbohydrates, provide better quality silage production compared to legumes (Li et al., 2022). On the other hand, sainfoin, which is a legume, has a high dry matter yield and high nutritional value in the early period, making it suitable for silage production with a quality fermentation (Cavallarin et al., 2005). Moreover, tannin-containing species such as sainfoin undergo less protein degradation during ensiling than non-tannin-containing species. However, direct ensiling of legumes may be insufficient to initiate the production of lactic acid and prevents the pH decrease and causes the increase of acetic acid and undesirable microorganisms such as yeast and mold (Muck, 2013). It is also well known that when storing legumes as silage, severe protein degradation occurs due to the combined effect of both plant and microbial activity. This can reduce the nutritional value of silage, dry matter uptake by ruminants, and nitrogen utilization efficiency. For this reason, it is more beneficial to ensilage sainfoin silage as a mixture of additives or grasses such as maize and sorghum. Moreover, mixed plantings for silage increase yield and quality, as well as ease of harvest and silage (Basaran et al., 2018).

In order to meet all of these needs, silages were made using four different mixing ratios for sainfoin, maize, and sorghum cultivation. The investigation of the impact of seeding rates on the yield and chemical composition of silages was a consequence of the study.

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2. MATERIAL AND METHODS

In the study, sainfoin (*Onobrychis sativa* Lam.; SA), maize (*Zea mays* L.; M), and sorghum (*Sorghum bicolor* L.; S) plants were grown in the vegetation period of 2022 with different mixing ratios. The mixture ratios were determined in 3 ratios (80%M-20%SA, 60%M+-0%SA, 30%M-70%SA; 80%-+20%SA, 60%S-40%-SA, 30%S-70%SA) binary mixtures for both grasses, and pure sowing (100%) as control. This experiment was established using a randomized blocks experiment design, with three replications in the research field of Yozgat Bozok University (with an average monthly minimum temperature of 11.6°C, an average 89 monthly maximum temperature of 22.7°C, and a total precipitation of 174 mm). The soil of the experimental area was clay-loam with medium lime content (10.95%), low salinity (0.21%), a saturation of 76.27%, and a high pH value (7.56). It also contained high organic matter (6.65%), medium phosphorus (11.50 kg da^{-1}), and high potassium (485.90 kg da^{-1}). The seed rate was calculated based on the sowing rate of each plant individually: 12.000 plant da^{1} for maize, 3 kg da^{-1} for sorghum, and 8 kg da^{-1} sainfoin. Sowing was done in April on 6-meter-long plots with a distance of 35 cm for sainfoin and 70 cm for maize and sorghum (sole sowing). The mixtures were made by sowing sainfoin seeds between rows of maize and sorghum (Figure 1). Irrigation was done twice during the growing period. The plots were harvested on August 18, 2022, for silage, in account of the development period of maize and sorghum (at 65-70% humidity).

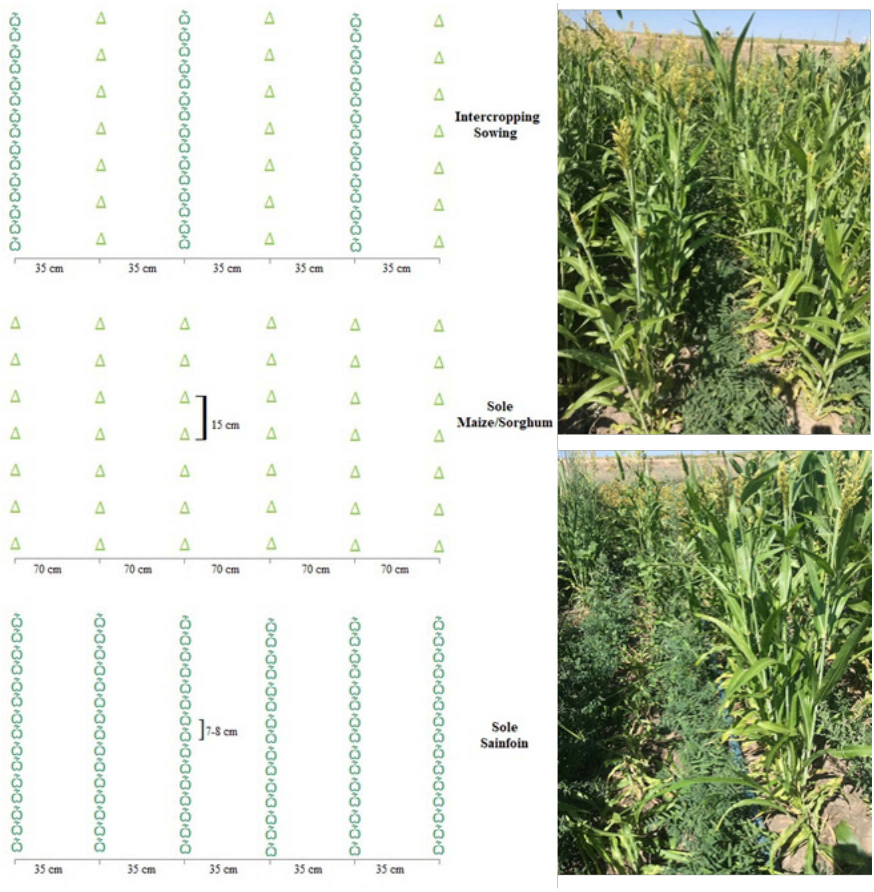

Figure 1. Sole and intercropping system in an experiment

2.1. Fresh Yield, Hay Yield, and Silage Preparation

Weighing the plants in a 1 m^2 area that was evenly distributed among the plots allowed us to calculate the fresh yield (kg da^{-1}) (three repetitions). Hay yield (kg da-1) was determined by weighing the plants after 105 drying at 65 °C. Following the mixing ratios, the collected plants were cut into 2 cm pieces (Gulumser et al., 2021b) and placed into 1.0 kg plastic cans with three replications. After being packed airtight, the silages were allowed to ferment for 45 days at 25±2 °C.

2.2. Physical Analyses, Dry Matter Ratio, and pH

As mentioned by Alçiçek and Özkan (1997), physical analyses (smell, structure, and color) were performed after the cans were opened during fermentation, with the top 3–4 cm being eliminated. Weighting a 100 g dried sample from each silage at 105 ^{0}C allowed us to compute the dry matter ratio. 20 g of sample was homogeneously combined with 100 ml of distilled water in a blender to measure the pH of the silages, and the mixture was then filtered using filter paper into 50 ml Eppendorf tubes (Basaran et al., 2018). HANNA Edge, a digital pH meter, was used to measure pH.

2.3. Crude Protein, ADF, NDF, and Mineral Matters Ratios Analyzes

After drying the 100 g silage sample at 65 °C until it reached a constant weight and grinding it to less than 1 mm, various quality features were determined. Crude protein, Ca, Mg, K, and P ratios, as well as ADF (acid detergent fiber) and NDF (neutral detergent fiber), were measured using the IC-0904-FE calibration software on a Foss NIR Systems Model 6500 Win ISI II v1.5 instrument.

2.4. Organic Acid Analyzes

The HPLC (Shimadzu, Kyoto, Japan) auto sampler system model LC - 20AT, equipped with four pumps and an SPDM20A diode array detector (DAD), was used to quantify the organic acids (lactic, acetic, and butyric acids). HPLC analysis revealed that butyric acid was not present in every silage sample.

2.5. Statistical Analyzes

The SPSS 20.0 program was used to analyze all of the data according to the randomized blocks experiment design. To identify and find the significant differences between treatments, the Duncan test was used; a p-value less than 0.05 was deemed to indicate a significant difference.

3. RESULT AND DISCUSSION

The analysis results (Figure 2, 3 and Table 1, 2) showed that the effect of different mixture ratios on all the examined features was significant ($p < 0.01$). The results of the main effects of the binary mixture ratios of sainfoin with maize and sorghum showed that the highest fresh yield was found in the 80%M-20%SA and pure maize plots while the lowest yield was measured in the control SA treatment (Figure 2). The hay yield results showed that the highest value was obtained from 80%M-20%SA treatment, while the lowest value was obtained from the pure SA plot (Figure 2). The results of the comparison mean of different plant and mixture ratios showed that the highest and lowest yields were related to the ratio of high biomass maize and sorghum, and maize mixtures are better than sorghum. Intercropping of leguminous forage crops with high biomass plants such as maize and sorghum generally results in an inversely proportional relationship between 139 the proportion of legumes and yield (Basaran et al., 2017). However, the most important effect of legumes in the mixture is to provide nutritional balance in nutrition. In contrast, Akdeniz (2019) cultivated blue split and bromine, which have a smaller biomass than sainfoin, in different locations and reported a decrease in fresh and dry grass yields with the decrease in the ratio of sainfoin in the mixtures. Basaran et al. (2018) have declared that alfalfa-sorghum intercropped at a 100%:60% seed ratio produced the highest hay yield.

Table 1. Crude protein ratio, pH and dry matter (DM) ratio of silages

Treatments	DM (%) **	pH**	Crude Protein**
Sainfoin	41.01 a	6.28 a	24.94 a
Maize	29.57 g	4.18 e	12.09 f
Sorghum	37.67 d	4.93 bc	13.66 e
80%M-20%SA	31.52 f	4.17 f	13.96 e
60%M-40%SA	36.08 e	4.55 d	20.43 c
30%M-70%SA	39.11 bc	4.52 de	21.33 c
80%S-20%SA	38.08 cd	4.50 de	14.93 d
60%S-40%SA	38.30 cd	4.67 cd	20.46 c
30%S-70%SA	39.69 b	5.23 b	22.47 b
Mean	**36.78**	**4.78**	**18.25**
Standard error (SE)	**1.27**	**0.21**	**1.53**

There is no difference between the means shown in same letter ($p<0.05$). **:$p<0.01$

The DM content of sole silages showed significant differences, and the highest was in sainfoin (41.01%) and the lowest in maize silage (29.57%). Similarly, the highest pH was determined in sole sainfoin (6.28), while the lowest was determined in 80%M-20%SA (4.17). When the sainfoin ratio was lowered, the combination silages' DM and pH significantly fell. As expected, the highest CP was found in sole sainfoin (24.94%), and CP increased when the ratio of sainfoin in the mixture was raised. The lower CP was determined in sole maize (12.09%) (Table 1).

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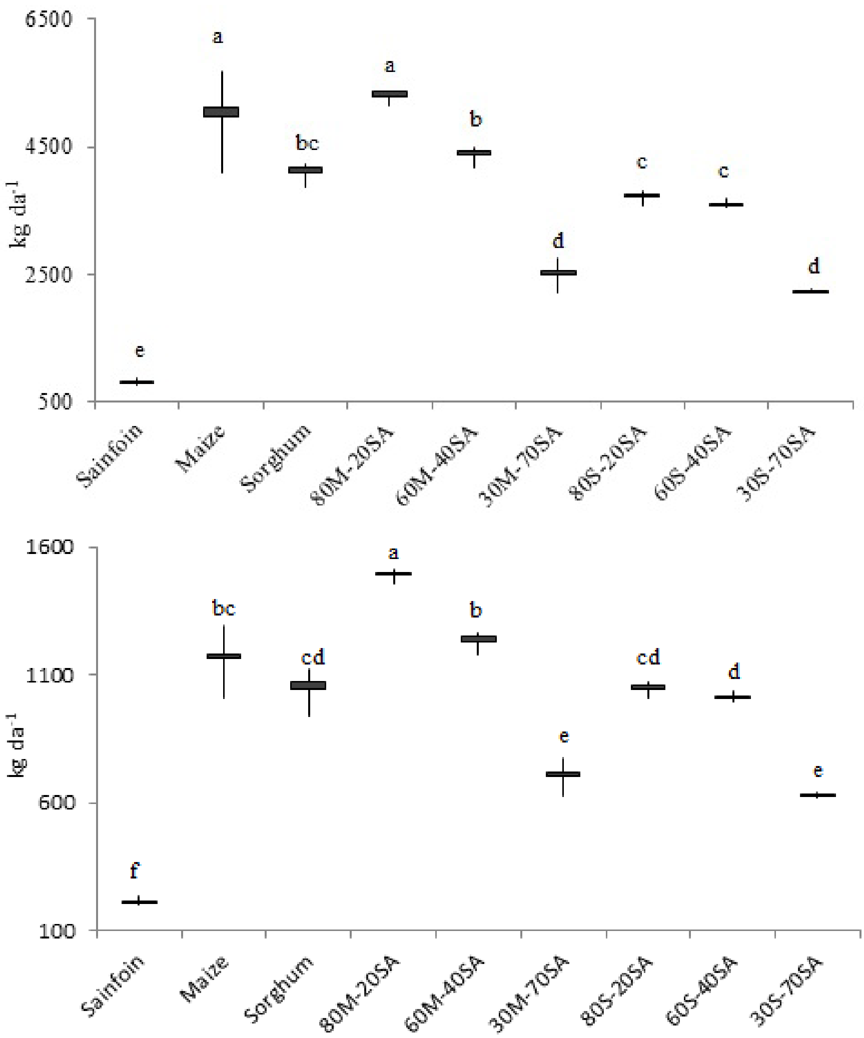


There is no difference between the means shown in the same letter (p<0.05). **:p<0.01.

Figure 2. Effects of the binary mixture ratios of sainfoin with maize and sorghum on fresh** and hay yield**

Table 2 shows the chemical composition dynamics of silages. The ADF content of the silages varied between 19.12 (30%S-70%SA) and 35.74% (sole sorghum), while NDF ranged from 40.06% (sole sainfoin) to 66.28% (sole sorghum). The silages' increases in calcium and magnesium occurred concurrently with the mixture's higher sainfoin content. Mg content in silages of 30%M-70%SA and 30%S-70%SA were found to be high, respectively 0.45 and 0.44%. The highest potassium content (3.69%) was obtained from sole sorghum. The phosphor content of 80S-20SA was higher (0.35%) than that of others.

Table 2. Chemical composition (%) of silages

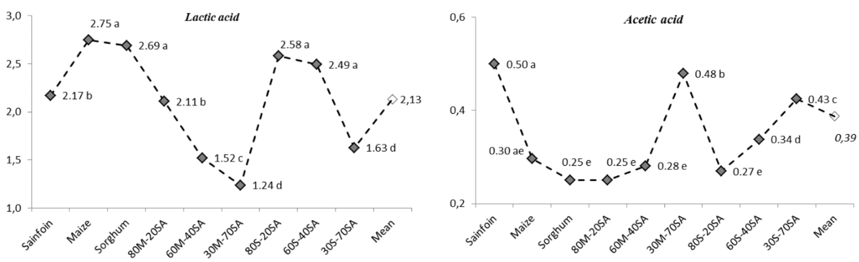
Treatments	ADF**	NDF**	Ca**	Mg**	K**	P**
Sainfoin	23.74 cd	40.06 f	2.18 a	0.45 a	2.52 d	0.34 b
Maize	35.35 a	65.59 a	0.79 g	0.37 e	3.01 bc	0.34 b
Sorghum	35.74 a	66.28 a	1.08 f	0.39 d	3.69 a	0.33 c
80%M-20%SA	33.09 ab	60.84 b	1.07 f	0.37 e	2.80 cd	0.30 e
60%M-40%SA	27.89 a-d	47.95 d	1.87 cd	0.44 b	2.70 d	0.30 e
30%M-70%SA	25.64 bcd	45.75 e	1.10 b	0.45 ab	2.73 d	0.34 b
80%S-20%SA	33.61 ab	60.16 b	1.32 e	0.42 c	3.25 b	0.35 a
60%S-40%SA	29.34 abc	51.72 c	1.79 d	0.44 b	3.02 bc	0.32 d
30%S-70%SA	19.12 d	48.67 d	1.93 bc	0.44 ab	2.74 d	0.34 bc
Mean	**29.28**	**54.11**	**1.56**	**0.42**	**2.93**	**0.33**
Standard error (SE)	**1.90**	**3.12**	**0.16**	**0.010**	**0.11**	**0.005**

There is no difference between the means shown in the same letter ($p<0.05$). **:$p<0.01$

Organic acids content in sainfoin with maize and sorghum binary mixtures were given in Figure 2. The highest lactic acid was found in sole maize (2.75%), sole sorghum (2.69%), 80%S-20%SA (2.58%), and 60%S-40%SA (2.49%). The acetic acid of silages ranged from 0.50 to 0.25%. Due to the low water-soluble carbohydrates of legumes, the lactic acid level has increased according to the maize and sorghum ratio, but the acetic acid level decreased. Compared to maize, the highest LA and AA contents were observed in mixtures with higher ratios of sorghum (80S-20SA and 60S-40SA silage). In addition, it was seen that the addition of sorghum to sainfoin silage increases lactic acid content compared to maize (Figure 3).

A mixed cropping system effectively improves the utilization rate of resources on the same land, increasing yields and quality. According to Jeroch et al. (1999), before ensiling, the fresh mass and dry matter accumulated by the silage plants should be adequate to provide the highest-quality, most profitable silage. In this study, sainfoin and silage plants were cultivated both alone and in combination. The production of fresh and hay from the 80M-20SA mixed plant was higher than that of the other cultivars. However, the decrease in the rate of maize and sorghum with high biomass in the mixtures caused a decrease in yield. Many researchers support these results (Gianoli et al., 2006; Basaran et al., 2017; Lienhard et al., 2020; Igbal et al., 2021).

A common practice in forage conservation is ensiling, which is based on spontaneous fermentation caused by epiphytic lactic acid bacteria (LAB) that produce lactic acid (LA) from water-soluble carbohydrates (WSC) in the absence of oxygen. Consequently, the forage is maintained, and the pH drops (Weinberg et al., 2001). Legumes have low WSC, which results in lower silage quality, but they have high DM and protein content. On the other hand, in maize and sorghum silages, the reverse of this situation is present. Maize is the most widely used type in silage production, but due to problems such as groundwater scarcity, plant attacks by certain parasites, and mycotoxin contamination in its cultivation, it is necessary to consider alternative crops. For these reasons, many researchers have used legume/grass mixtures in silages and have increased the quality and nutritional content of the silage (Lima et al., 2010; Amado et al., 2012; Gulumser et al., 2021a). Experiments on lactating cows have proven that replacing maize silage completely with sorghum silage does not affect milk yield and is an alternative product (Oliver et al., 2004; Colombini et al., 2012). In this study, it was determined that the quality of silage mixed with sainfoin was higher and sorghum was an alternative to maize.



There is no difference between the means shown in the same letter ($p<0.05$). **:$P<0.01$

Figure 3. Effects of the binary mixture ratios of sainfoin with maize and sorghum on lactic** and acetic acid** ratio of silages

Panyasak and Tumwasorn (2013) reported that 25-40% of dry matter should be in quality silage. Otherwise, if the DM *content* is more than 60% or less than 25%, deterioration occurs. In this case, *Clostridium* spp. anaerobic bacteria begin to grow, resulting in the decomposition of sucrose and protein into butyric acid and ammonium. This situation raises up to 5.0 the pH, which should be between 3.7 with 4.8 (Fiyla, 2001), and it reduces silage quality. In addition, low DM silage causes an increase in acetic acid content and unwanted epiphytic microorganisms, thus reducing the fermentation process and quality of the silage (Jeroch et. al., 1999). In the study, DM results were suitable for all processes except for sole sainfoin, while the pH content was found in others except for sole sainfoin, sorghum, and 30%S-70%SA treatments. Moreover, the pH values decreased with an increased percentage of maize silage in the mixtures, possibly due to pure maize having a high WSC content suitable for lactic acid production. Ke et al. (2017, 2018) showed a pH value even higher than 5.0 in alfalfa and grass silage, and such inconsistency can be attributed to different application rates and species. As a result of the physical evaluation of the silages, sole sorghum, 80%M-20%SA, and 80%S-20%SA were found to be successful.

The amount of ADF and NDF in silages influences the amount of energy dairy cows obtain from silage-based diets and consequently, milk production (Ferraretto et al. 2015; Tharangani et al. 2020). NRC (2001) states that silages of a high caliber should normally have 25–35% ADF and 40–50% NDF. Except for 30%S-70%SA in ADF content and sole treatments in NDF, other treatments were found suitable. Similar results were found in like studies (Baležentienė and Mikulionienė, 2006; Seydosoglu, 2019; Mut et al., 2020; Gulumser et al., 2021a,b). The plant type, the harvest time, and the competition from a high mixed planting density might all be contributing factors to the decline in these contents. Moriri et al. (2010) showed that flowering and maturity of plants were delayed by intensification of interspecific competition, which may be the reason for the affected NDF content.

Well-fermented silage generally has a higher nutrient content (Kung et al. 2018). In the present study, CP content increased with increasing sainfoin sowing density. Zeng et al. (2020) announced that soybean effectively compensated for the low CP content in maize silage in its study. Baghdadi et al. (2016), reported that as the proportion of soybeans in the mixed silage decreased, the CP content also decreased significantly, and our study found similar results, with maize having the lowest CP content. The elements that must be obtained from the feed for the animals to carry out their tasks in a healthy manner are the mineral substances that are studied in silages (Yogeshpriya and Selvara, 2018; Trailokya et al., 2017; Arnoud, 2008). According to Kidambi et al. (1993) and Tekeli and Ateş (2005), forage must have a minimum of 0.8% K, 0.21 P, 0.3 Ca, and 0.1 Mg in order to provide animals with a balanced diet. Furthermore, compared to grass, legumes have a higher nutritious value. The silages in this study were all higher than these mineral content levels. Additionally, solitary sainfoin had a substantially greater Ca concentration than the other components, but not of the other.

The main fermentation product in silage is lactic acid, which is also a crucial indicator of silage quality. Ruminant performance is impacted by the organic acids found in properly fermented silage, which serve as energy sources (Daniel et al. 2013). Lactic acid bacteria (LAB), which is found naturally in plants, is the source of lactic acids, the most significant of these organic acids. Crop LAB counts vary greatly by species, ranging from 1 × 107 CFU/g (colony-forming units) in sorghum and maize to the lowest detection limit of 10 CFU/g in alfalfa (Broberg et al., 2007; Comino et al., 2014). Acetic and butyric acid levels rise in proportion to the amount and rate of lactic acid formation (Guo et al., 2018). The primary metabolite of Acetobacter, acetic acid, is constantly present in large concentrations and raises pH, which is favorable to the growth of undesirable bacteria such as Clostridia (Zheng et al., 2017). This results in a drop in the protein level and nutritional value of silage, which lowers its quality. According to Alçiçek and Özkan (1997), lactic acid in high-quality silage should be greater than 2% and acetic acid less than 0.8%. Our results fell within these ranges. Better-quality silage was produced in comparison to lean ones by increasing lactic acid production, decreasing pH and acetic acid in silages, and altering the mixing ratios. It was shown that compared to maize, the combination made with sorghum had more lactic acid and less acetic acid. Therefore, the optimal choice was 80%S-20%SA and 60%S-40%SA from the perspective of chemical composition and fermentation quality in the conditions of the experiment. While Basaran et al. (2018) revealed that levels of different ratios of mixed had variable effects, Gulumser et al. (2021a) said that can enhance lactic acid content with mixes. This conclusion was consistent with prior findings (Li et al., 2022). Different effects have been observed in other studies, as well (Li et al., 2016; König et al., 2019). The plant species, culture, climate, soil fertility, growing season, and harvest timing may all contribute to these variations in silage quality.

4. CONCLUSIONS

The primary objective of this study was to maximize land use efficiency in an intercropping system by preparing silages with mixed legume and grass. This approach aims to minimize dry matter loss, promote lactic acid production, suppress undesired microorganisms, and increase nutritional quality. As a result, sainfoin and maize/sorghum silage complement each other well, and intercropping these combinations resulted in high-quality silage and fodder output. Before ensiling, the combined forage yields exceeded those of pure. Notably, the 80%S-20%SA combination yielded the highest. It is confirmed that using sainfoin alone for silage is less advantageous, as indicated by positive indices such as high hay yield, lactic acid contents, and chemical composition specified before ensiling within maize and sorghum sainfoin mixes. We have found that all of the studied parameters had mixed ratios of beneficial impacts. However, 80%S-20%SA and 60%S-40%SA mixed silage outperformed the others, suggesting that sorghum could be a viable substitute for maize.

Conflict of Interest

The authors declare that there is no conflict of interest.

Ethics

This study does not require ethics committee approval.

Author Contribution Rates

Design of Study: MÇD (%50), UB (%50)

Data Acquisition: MÇD (%30), UB (%30) EG (%20), HM (%20)

Data Analysis: MÇD (%40), UB (%30) EG (%30)

Writing up: MÇD (%30), UB (%30) EG (%30), HM (%10)

Submission and Revision: MÇD (%50), EG (%50)

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