Selcuk Journal of Agriculture and Food Sciences

https://dergipark.org.tr/tr/pub/selcukjafsci

Research Article

SELCUK UNIVERSITY PRESS

(2024) 38(3), 434-444 DOI:10.15316/SJAFS.2024.039 e-ISSN: 2458-8377 Selcuk J Agr Food Sci

Silage Yield and Quality of Forage Peas and Hungarian Vetch and Triticale Binary Mixtures

Ahmet Mirza[1], Medine Çopur Doğrusöz[2,*]

[1]Yozgat Bozok University, Graduate School of Education, Department of Field Crops, Yozgat, Türkiye

[2]Yozgat Bozok University, Graduate School of Education, Department of Field Crops, Yozgat, Türkiye

HIGHLIGHTS

- The importance of mixed cropping and silage in forage crop production is understood in Turkey as well as all over the world.
- The study integrated the mixed cropping system, which provides better quality feed in silage production and more effective use of unit area.
- In this context, the silage quality of legume + triticale planting rates was determined and the 80:20 T/HV process came to the fore.

Abstract

This study was conducted to determine silage quality in binary mixtures of forage pea (*Pisum sativum* ssp. *arvense* L. "FP") and Hungarian vetch (*Vicia pannonica* C. "HV") and triticale (X *triticosecale* Wittmack. "T") in 2021-2022 vegetation period. Hungarian vetch, forage pea, and triticale seeds were sown in 6 different mixture ratios (legume/triticale; 100%/0, 80/20%, 60/40%, 40/60%, 20/80%). The experiment was established according to a randomized blocks experimental design with 3 replications. In the study, dry matter content, pH, flieg score, quality class, crude protein, ADF, NDF, Ca, K, Mg, P, lactic acid and acetic acid contents were analyzed for silage yield and quality. The dry matter of silages was between 23.83 and 36.49%, while the pH was between 4.57 and 5.18. The highest crude protein was determined in pure forage peas (22%) and it was determined that it increased in parallel with the increase in the legume ratio in the mixture. Mineral contents were found to be high in sole and intense legume silages, similar to crude protein. In terms of silage quality in the examined parameters, mixed sowing gave better results than sole sowing. As a result of the study, 80:20 T/HV mixture ratio sowing is recommended for Yozgat and regions with similar ecology in terms of silage yield and quality.

Keywords: Hungarian vetch; Triticale; Forage pea; Silage quality

Citation: Mirza A, Çopur Doğrusöz M (2024). Silage Yield and Quality of Forage Peas and Hungarian Vetch and Triticale Binary Mixtures. *Selcuk Journal of Agriculture and Food Sciences*, 38(3), 434-444. https://doi.org/10. 15316/SJAFS.2024.039

Correspondence: medine.copur@bozok.edu.tr

Received date: 30/01/2024

Accepted date: 02/10/2024

Author(s) publishing with the journal retain(s) the copyright to their work licensed under the CC BY-NC 4.0.
https://creativecommons.org/licenses/by-nc/4.0/

1. Introduction

High forage costs in Turkey are a major problem for animal production enterprises. The insufficient level of roughage produced is the main reason of forage cost increase significantly (Ceyhan and Karadaş 2022). Livestock production in Turkey depends on a large amount of pastures. Due to excessive and prolonged grazing of pastures, these areas, which are a source of cheap forage, are insufficient for animal production. Therefore, to meet the need for roughage in Turkey and increase animal production, it can be achieved by increasing the production of forage crops.

The forage crops have characteristics such as quality forage source for animals, can leave fertile soil for the plant, uses in the crop rotation, and can conserve water and soil (Ceyhan et al. 2012). Also, the essential energy for animals to have a balanced and adequate nutrition should be provided from forage crops. For this purpose, it is appropriate to plant legumes mixed with grasses. In Turkey, silage obtained from intercropping of leguminous with grasses, which has become increasingly widespread in recent years, has become an important source of roughage. Silage is deliciously consumed by animals because of its high water content and fresh.

Forage peas and vetch, which have high protein content, together with cereals with high starch content, provide an easy-to-digest and high quality feed for animals (Elçi 1975). By intercropping legumes with cereals, diseases such as tympani and grass tetenosis that occur in animals can be reduced. Silage, which is one of the most important quality forages, is widely used in many countries around the world due to its ability to reduce losses in forages due to its high water content. With silage production, animals can access fresh quality roughage throughout the year. Legume silages have a higher nutritional value for dairy cows compared to cereals. However, due to their high protein content and high buffering capacity, it is more difficult to make silage than cereal (Keleş et al. 2013). Because the low protein content of cereals negatively affects the quality, especially in silage production, while the lactic acid and pH amounts are not at the desired level with pure legumes, so the increase in lactic acid, protein and pH amounts when cereals are sown together or mixed with legumes is an essential factor.

This proposed study was planned to determine the silage yield and quality in the intercropping of Hungarian vetch (*Viciapannonica* Crantz.) and forage pea (*Pisum sativum ssp.arvense* L.) and triticale (*Xtriticosecale* Wittmack.) at different rates.

2. Materials and Methods

Hungarian vetch (HV; *Vicia pannonica* Crantz.) Altınova 2002, forage pea Özkaynak (FP; *Pisum sativum* ssp. *arvense* L.) and triticale (T; X *triticosecale* Wittmack.) Karma 2000 seeds were used as material in the study.

Soil samples taken from 3 different parts of the land and 30 cm depth were analyzed by Yozgat Chamber of Agriculture. When the soil properties of the research site are analyzed, it is seen that it has a soil structure with clay loam, slightly salty, medium calcareous, medium organic matter content and high phosphorus content.

As seen in Table 1, the long-term rainfall average for the growing period in which the research was carried out in Yozgat conditions was 544.6 mm. This data was realized as 562.4 mm in the year the study started, and 17.8 mm more rainfall was realized in the 2021-2022 growing period compared to the long-term average.

The average temperature in Yozgat for many years (1929-2021) was 7.1°C. The average temperature in the 2021-2022 growing period in which the study was conducted was 6.9°C. This value is lower than the long-term average. Relative humidity in Yozgat is 68.7% according to the long-term average and 67.5% in the 2021-2022 growing period.

Table 1. The climate data for 2021-2022, the year of the study, and for many years (1929-2021) are presented in Table 1.

	Total Precipitation(mm)		Average Temperature(°C)		Average Relative Humidity (%)	
Months	**2021-2022**	**Long Years**	**2021-2022**	**Long Years**	**2021-2022**	**Long Years**
November	65.4	53.7	6.6	5.1	72.8	71.9
December	77.1	75.9	1.9	0.6	74.7	77.7
January	121.1	67.9	10.1	-1.7	62.9	77.6
February	48.8	59.8	-2.4	-0.6	76.6	75.3
Mart	83.3	68.2	0.2	3.0	77.1	70.9
April	16.4	58.3	-1.5	8.5	73.9	64.9
May	50.2	66.3	11.6	13.1	47.4	63.5
June	98.9	67.4	17.5	16.7	64.3	60.7
July	1.2	27.1	18.5	19.6	57.9	56.0
Total/Mean	**562.4**	**544.6**	**6.9**	**7.1**	**67.5**	**68.7**

Data of the General Directorate of Meteorology for Yozgat province for many years and the year of the research (Anonymous, 2023)

The experiment was conducted at the YOBU Research and Application Center during the 2021/2022 vegetation period. Sowing was carried out in November with four different ratios for each legume (80HV-FP+20%T, 60%HV-FP+40%T, 40%HV-FP+60%T, 20%HV-FP+80%T) and lean. The experiment was established according to the Randomized Block design with three replications. In the experiment, the plots were 6 meters long with a row spacing of 20 cm, 6 rows were sown by hand, and one row was sown as wheat and one row as legume. The amount of seed per decare was adjusted as 12 kg for Hungarian vetch and forage pea and 22 kg for triticale. The amount of seed to be included in the mixtures was calculated based on the amount used in lean sowing and the mixture ratio (Önal and Eğritaş 2017). The experiment was irrigated 1 time.

Preparation and examination of silages

Harvesting time for silage was based on the developmental stage of triticale in the mixtures, triticale was harvested at the dough stage and legumes were harvested when the lower pods started to form. Harvested samples for silage were chopped into 2 cm pieces according to the mixture ratios (Alaca and Özaslan Parlak, 2017) and filled into 1.0 kg plastic drums in 3 replicates. The silage samples were left for fermentation airless and at 25±2 °C. The fermented silages were opened after 45 days. Silage sampling was done by removing the top 3-4 cm of the bins and the following parameters were analyzed.

The physical analyses determined after opening the silage samples are given in Table 2. For pH, 100 ml of distilled water was added to 20 g of samples taken from the silages and mixed homogeneously with the help of a blender and filtered through filter paper and filtered into 50ml sieve tubes (Başaran et al. 2018). The pH of the obtained silage water was determined with a HANNA Edge digital pH meter. Flieg score which one of the common methods used to determine silage quality is the relationship between dry matter content and pH of the silage.

FP=[220+(2XsilageCMRatio-15)]-40XsilagePH (Anonymous, 1987).

The 100 g from the fermented silage samples were dried in an oven at 1050 C until reached constant weight and dry matter content (%) was determined by the weighing. For chemical analysis, 100 g of silage sample was dried at 60 0 C and ground 1mm diameter. Afterwards, the total N values of these samples were determined by the Kjehldahly method and crude protein ratios were calculated by multiplying these values by a coefficient of 6.25 (Basaran et al. 2018). ADF, NDF and mineral matter contents (Ca, K, Mg and P) (%) were determined using IC-0904-FE calibration program on FossNIRSystemsModel6500WinISIIIv1.5

instrument. Lactic, acetic and butyric acid analyses in silage samples whose pH was determined were carried out by HPLC (high performance liquid chromatography) device at YOBU, Science and Technology Application and Research Center. Butyric acid was not found in silage samples.

Table 2. Physical evaluation key of silages developed by the German Agricultural Organization (DLG).

1. Odor	**Score**
No buttery acidic odor, slightly sour, fruity and aromatic odor	14
Small amounts of butter acid, strong odor of heat and mild frying	8
Moderate odor of butter-oil acid, strong smell of fumes	4
Strong odor of butter-acid or ammonia, very light odor	2
Strong smell of rot, ammonia and mold	0
2.Appearance (Structure)	
Leaves and petiole structure intact	4
The structure of the leaves is slightly deformed	2
Leaves and leaves are decomposed, moldy and dirty	1
Leaves and stalks rotten	0
3.Color	
Retains its color when siloed (brown in withered silage)	2
Color slightly changed (yellow to brown)	1
Color completely changed (musty-green)	0

Statistical analyzes

The results obtained were subjected to analysis using SPSS 20.0 statistical package program according to randomized blocks experiment design. The averages of the treatments between which differences were determined were evaluated according to the Duncan multiple comparison test and grouped.

3. Result and Discussion

The averages of the physical and chemical parameters of the silages prepared from different mixture ratios of Hungarian vetch, forage pea and triticale and their Duncan grouping are shown in Table 3. The difference between the mean values of all the characteristics was found to be statistically very significant ($p<0.01$). Table 3 shows that the silage dry matter ratio was between 23.83 and 36.49, while the pH was between 4.57 and 5.18. The highest silage dry matter ratio was 100% T (36.49) and the lowest silage dry matter ratio (23.83) was 100% HV. The highest silage pH value was obtained from 100% triticale and the lowest value was obtained from 60:40 T/HV (4.57). As the legume (forage pea and Hungarian vetch) ratios decreased in the mixtures, an increase in dry matter ratio was observed. One of the most important factors determining the quality of silage is the dry matter content of silage. It has been proved by most studies that the increase or decrease in the dry matter content increases the quality of forage (Mut et al. 2020). The highest (89.24) fleig score calculated in silage samples was observed in 80:20T/HV mixture and the lowest (52.94) was observed in 100% HV. Also, while 40:60T/HV, 60:40T/HV and 80:20T/HV were in the same group, 20:80T/HV was in a different group. The highest quality class was 80:20T/HV (89.24) and 60:40T/HV (82.34) and the quality class were 'very good'.

In previous studies, Akgül (2010) reported that the dry matter content of green forage to be silage should be (25-30%). Gümüştaş and Turan (2022) found the most high dry matter content was in 75% forage peas + 25% cereal silage. Yavuz (2022) found that the highest dry matter rate (32.08%) and pH (4.65) were determined from pure barley. In similar studies, Ashbell (1997) found the highest dry matter content (38%), Arslan and Çakmakçı (2011) found the highest dry matter content (31.38%) and Dumlu et al. found the highest (31.36%). Abeidy (2022) reported that the pH values of oat + legume silages were varied between to 4.72-6.56. Gomes et al. (2019) investigated the addition of heterofermentative lactic acid bacteria in lightly wilted or directly harvested oat silage and reported that pH values were (3.90-4.61), (4.05- 4.59), respectively. Romero et al, (2017) pH values of silages prepared in polyethylene bags and plastic drums in control and inoculant groups were (6.10-6.04), (6.13-6.16), respectively. Erbil (2012) investigated the effects of heterofermentative and/or homofermentative lactic acid bacteria in Hungarian vetch + wheat grain mixture silages, pH values were (4.59, 4.42, 4.40 and 4.37) on the 2nd, 4th, 8th and 45th days, respectively; Marković et al, (2018) reported that the pH values were between (4.13-4.89), (4.17-4.61), respectively (4.13-4.89) in their study investigating the addition of bacterial inoculant to mixtures of common vetch and oat at different ratios. Polat (2022) reported that the highest silage dry matter rate was determined from pure oat (31.49), the highest silage pH value was between 4.57 and 5.52 and the highest pH value was determined from pure forage pea (5.52). Yavuz (2022) reported in his study that the highest values in flieg score and quality criteria were obtained from pure barley in both (16-90) and were classified as very good. Polat (2022) reported that the average values of flieg score varied between 30 and 80 and the highest value was obtained from oat + faba bean (75:25) and was classified as good. Mut et al., (2020) concluded that when the flieg scores and crude protein ratios of the silages were evaluated together, it was concluded that the quality of the silages made with alfalfa and forage turnip in all the ratios considered and with oat at a ratio of 75+25% were higher. Karadeniz et al. (2020) obtained the highest flieg score from triticale silage in their study.

Table 3. Dry matter content (DM;%), pH, flieg score and quality class in silages of triticale with legumes silages mixtures.

Treatments	DM**	pH**	Flieg score**	Quality Class
Triticale(T)	36.49 a	5.18 a	72.02 c	Good
Hungarian vetch (HV)	23.83 g	4.98 b	52.94 f	Middle
Forage pea (FP)	22.75 g	4.78 c	59.90 e	Middle
20:80T/HV	27.50 e	4.63 e	74.86 bc	Good
40:60T/ HV	31.10 cd	4.72 d	77.64 b	Good
60:40T/ HV	31.36 cd	4.57 f	82.34 ab	Very good
80:20T/ HV	32.66 b	4.58 f	89.24 a	Very good
20:80T/FP	25.62 f	4.76 c	65.46 d	Good
40:60T/ FP	27.76 e	4.65 e	77.16 b	Good
60:40T/ FP	30.59 d	4.69 d	79.76 b	Good
80:20T/ FP	32.14 bc	4.71 d	79.68 b	Good
Mean	29.25	4.75	73.72	Good

**:$p<0.01$; there is no difference between means indicated with the same letter ($p<0.05$).

The highest (22.82%) crude protein in silage samples was in 100% FP and the lowest (6.34%) crude protein content was in 100% T. As the legumes ratios in the mixtures decreased, the crude protein ratios also decreased linearly as expected. Also, the average CP of the samples was (13.89%). The highest ADF and NDF contents were in sole triticale (40.16%) and (69.0%), respectively. The lowest ADF and NDF contents were (22.82%) and (39.8%) in sole forage pea (Table 4).

Similarly, Yavuz (2022) and Karadeniz et al. (2020) determined that legume silages had higher protein content. However, Görü and Seydoşoğlu (2021) reported that the highest CP ratio was found to be 75% in the mixture of common vetch. Kaymak et al., (2021) reported that the highest CP was obtained from a mixture of 80%B+20%WW (15.58%) and 80%B+20%WW (15.58%) mix silages. In their study, Mut et al. (2020) found that the quality of the silages made with alfalfa and forage turnip and oats at a ratio of 75+25% were higher in terms of their crude protein ratios.

Table 4. Crude protein content (CP; %), ADF (%) and NDF (%) contents in silages of triticale with legumes silages mixtures.

Treatments	CP**	ADF**	NDF**
Triticale(T)	6.34 f	40.16 a	69.0 a
Hungarian vetch (HV)	18.81b	33.46 cd	46.8 d
Forage pea (FP)	22.82 a	22.82 f	39.8 e
20:80T/HV	14.28 c	35.64 bc	55.8 c
40:60T/ HV	11.41e	39.07 a	61.7 b
60:40T/ HV	10.85 e	37.16 ab	62.1 b
80:20T/ HV	11.28 e	36.93 ab	63.4 b
20:80T/FP	17.78 b	29.82 e	51.0 d
40:60T/ FP	14.80 c	30.73 de	55.8 c
60:40T/ FP	12.72 d	32.61 cde	58.6 bc
80:20T/ FP	11.72 e	33.35 cd	59.7 bc
Mean	13.89	33.80	56.71

**:$p<0.01$; there is no difference between means indicated with the same letter ($p<0.05$).

Kaymak et al. (2021) reported that the ADF content of silages varied between (25.87%-30.24%), Karadeniz et al., (2020) obtained the highest ADF rate from 100% damson silage. In Paydaş's (2018) study, the highest ADF rate was found in vetch silage with (44.46%) in May harvest period and the lowest ADF value was found in vetch silage with (31.76%) in May harvest period. Jung et al. (2015) found ADF values between (30.4% and 34.8%) by using a mixture of vetch and barley in their study on silage yield. Balabanlı et al, (2010) in their experiment on the quality of silages obtained from a mixture of common vetch and oat, the lowest NDF (50.11%) and ADF (31.92%) ratios were found in the mixture of common vetch + oat. Jung et al. (2015), found NDF ratios between 50.2% and 55% in their silage research with barley and vetch mixture.

Table 5. Mineral matter contents (%) in silages of triticale with legumes silages mixtures.

Treatments	Ca**	K**	Mg**	P**
Triticale(T)	0.33e	3.47d	0.18e	0.32e
Hungarian vetch (HV)	1.55a	4.56a	0.35a	0.34d
Forage pea (FP)	1.45a	3.58cd	0.36a	0.39a
20:80T/HV	1.20b	3.99b	0.32b	0.32e
40:60T/ HV	0.90cd	3.72c	0.28d	0.29f
60:40T/ HV	0.85d	3.53cd	0.29cd	0.31e
80:20T/ HV	0.79d	3.49d	0.28d	0.31e
20:80T/FP	1.07b	3.57cd	0.31bc	0.36bc
40:60T/ FP	1.04bc	3.50d	0.32b	0.36b
60:40T/ FP	0.86d	3.50d	0.27d	0.35cd
80:20T/ FP	0.86d	3.54cd	0.28d	0.36bcd
Mean	0.99	3.68	0.29	0.34

**:$p<0.01$; there is no difference between means indicated with the same letter ($p<0.05$).

Generally, Ca, K, Mg and P contents were found to be higher in legume silages than in mixtures (1.55, 4.56, 0.36 and 0.39%, respectively). Table 5 shows that the addition of legumes to silages provides significant increases in mineral content. Similar a study, Turan (2018) found that the average Ca, P, Mg, and K ratios of the silages obtained from different blends of Hungarian vetch and barley (1.31, 0.56, 0.20 and 3.01%, respectively). Kidambi et al. (1989) reported that the content of (0.31%) Ca, (0.65%) K, (0.1%) Mg and (0.21%)

P in the ration for regular feeding of animals. When the minerals in the silages obtained are compared with the findings of the researchers, it can be said that they are above the amount that should be present in the animal feed and this will not pose any nutritional problem for the minerals mentioned.

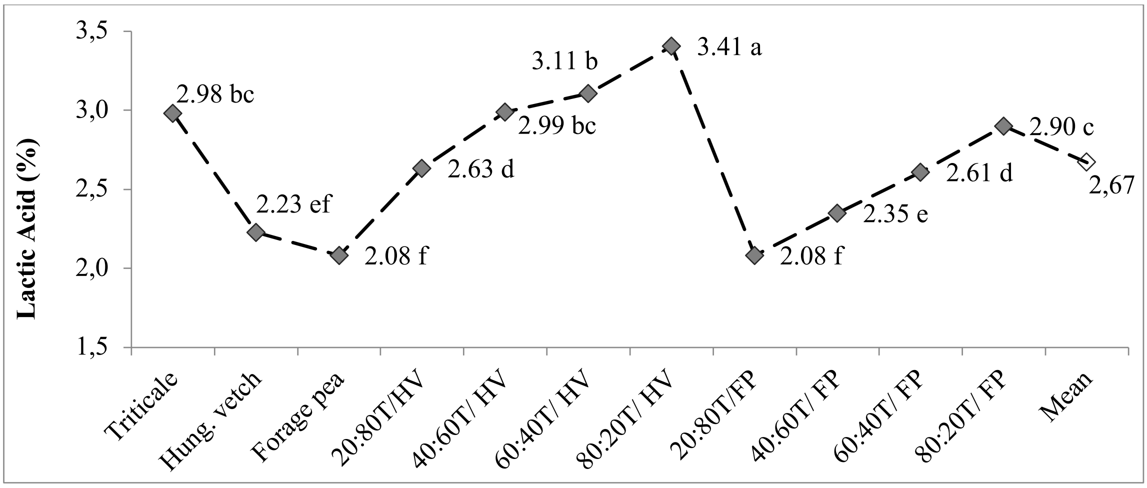

Figure 1. Lactic acid content in silages of triticale with legumes silages mixtures

The LA contents of the species in the study are given in Figure 1 and the results of the analysis were found to be very significant (p<0.01).The highest LA (3.41%) was in 80:20T/HV while the lowest LA (2.08%) was in 80:20T/HV and forage pea. In addition, the proportion of legumes in the mixtures (HV and FP) generally decreased while the LA content increased inversely. In other studies, Yıldırım (2020) found that the lactic acid rate in legumes varied between (1.80-2.03%), with the highest lactic acid rate (2.03%) in forage pea. However, in the study conducted by Paydaş (2018), the highest lactic acid value (29.08 g/kg) was obtained in barley silage with the highest KM ratio. In another study, Jung et al. (2015) reported that the highest lactic acid rate (3.27 g/kg) was obtained from barley and vetch mixture silage. Kavut et al. (2012) and Aykan and Saruhan (2018) obtained in the highest LA from sole grass silages. Açıkbaş (2022) reported that the highest LA ratio (1.56%) in branched millet silages was found in Cave in Rock variety.

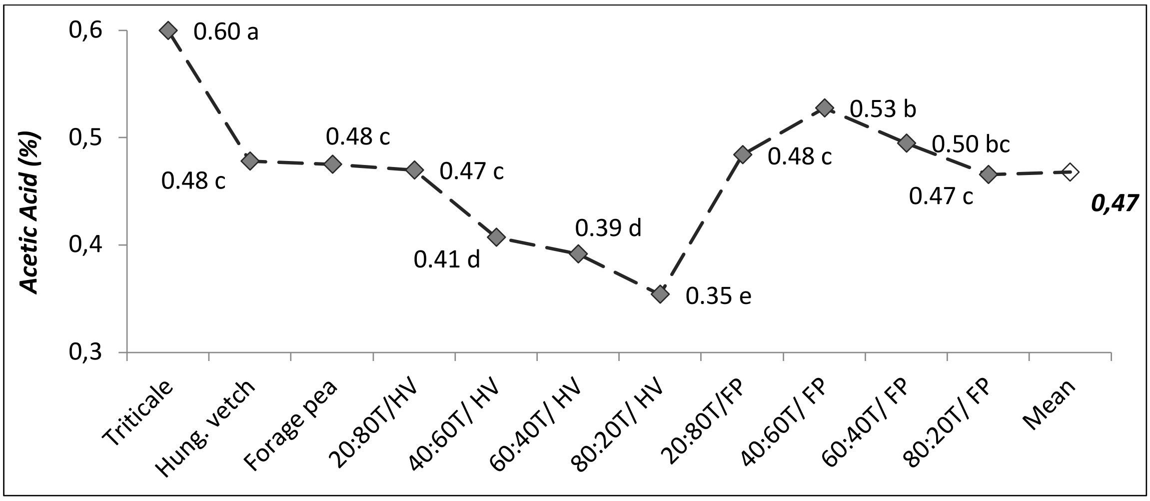

Figure 2. Acetic acid content in silages of triticale with legumes silages mixtures

The acetic acid (AA) contents of the treatments under investigation are illustrated in Figure 2, revealing highly significant results (p < 0.01). Among the different compositions, pure triticale exhibited the highest AA content at 0.60%, while the 80:20T/HV mixture had the lowest acetic acid content at 0.35%, resulting in an average AA content of 0.47% across all species. Notably, the 80:20T/HV mixture (0.47%) clustered with the 20:80T/HV (0.48%) mixture, demonstrating similar AA levels. Additionally, the linear increase in legume ratios in the mixtures (HV to FP) was associated with a general rise in AA content.

In a study by Jung et al. (2015) involving a barley and vetch mixture, the highest acetic acid content was observed in the 70% barley-30% vetch combination (0.20 g/kg), whereas the lowest acetic acid content (0.11%) was found in the barley-vetch silage. Kavut et al. (2012), investigating silage yield and characteristics of various triticale varieties, reported silage acetic acid ratios ranging from 0.40% to 0.60%.

Quality silage parameters were considered in accordance with established standards. Panyasak and Tumwasorn (2013) suggested that 25-40% of dry matter is essential for quality silage. Alçiçek and Özkan (1997) also highlighted the importance of lactic acid exceeding 2% and acetic acid being below 0.8%. Otherwise, deviations from these values can lead to deterioration, as the growth of Clostridium spp. anaerobic bacteria may occur, causing the breakdown of sucrose and protein into butyric acid and ammonium. This can elevate the pH up to 5.0, beyond the recommended range of (3.7 to 4.8) Filya (2002), compromising silage quality. Considering the nutritional needs outlined by Kidambi et al. (1993) and Tekeli and Ateş (2005), where forage should contain a minimum of 0.8% potassium, 0.21% phosphorus, 0.3% calcium, and 0.1% magnesium to provide a balanced diet for animals, it was determined that all mixed silages in our study met these quality criteria. Consequently, there was no indication of deterioration, and these silages are deemed suitable for healthy animal consumption.

4. Conclusion

When the quality parameters of the silage samples were evaluated together, it was determined that pure legumes/triticale silages were inadequate compared to the mixtures, and Hungarian vetch and triticale mixtures gave better results than forage peas. In addition, it was concluded that 80:20T/HV mixture produced better quality silage among the mixtures grown for silage in Yozgat conditions, especially in terms of LA and AA content when all examined parameters are evaluated together.

Author Contributions: Conceptualization, methodology, software, A.M. and M.CD.; formal analysis, investigation, resources, data curation, A.M.; writing—original draft preparation, writing—review and editing, visualization, A.M.; supervision and project administration, M.CD.

Funding: This research was funded by Project Coordination Application and Research Center, project number FYL-2022-1062.

Acknowledgments: This study was produced from A.M.'s thesis work. We would like to thank Graduate Education Institute and Project Coordination Application and Research Center in for their contributions.

Conflicts of Interest: The authors declare no conflict of interest.

References

Abeidy Z (2022). The effects of lactobacillus brevis inoculation into hungarian vetch, oat and mix silages on silage quality and aerobic stability. Master's Thesis, Ahi Evran University (unpublished), Türkiye.

Açıkbaş S (2022). Determination of herbage and silage characteristics of branched millet (*Panicum virgatum* L.) varieties at different mowing cycles. PhD Thesis, Siirt University (unpublished), Türkiye.

Akgül B (2010). The effects of lactic acid bacteria and enzyme mixture inoculants on fermentation properties and feed value in low dry matter corn silages. Master's Thesis, Namık Kemal University (unpublished), Türkiye.

Alaca B, ÖzaslanParlak AÖ (2017). Effects of corn, sorghum sudan grass hFPrid and soFPean, cowpea and guarin mixed plantings on silage yield and quality. *Journal of Çomü Faculty of Agriculture* 5(1): 99-104.

Alcicek A and Ozdogan M (1997). A Research on determination of silage quality in corn and barley silo feeds made under farmer conditions. *Journal of Animal Production* 37(1): 94-102.

Anonymous (2023). Yozgat Long years (1929-2021) and (2021-2022) Years Meteorological Information, https://www.mgm.gov.tr. (access date: 15.12.2022)

Anonymous (1987). Bewertung Von Grünfutter, Silage Und Heu. DLG-Merkblatt, No. 224. Dlg-Verlag, Frankfurt/M.

Arslan M and Çakmakçı S (2011). Comparison of corn (*Zea mays* L.) and sorghum silages made with different plants. *Akdeniz University, Faculty of Agriculture Journal* 24(1): 47-53.

Ashbell G (1997). Whole wheat plants for silage in sub-tropical climate. *Turkey First Silage Proceedings*. September 16-19, 1997, Bursa; Türkiye.

Aykan Y, Saruhan V (2018). Determination of silage quality characteristics of different ratios of ensiled mixtures of forage pea (*Pisum sativum* L.) and barley (*Hordeum vulgare* L.). *Dicle University, Faculty of Veterinary Medicine Journal Article* 11(2): 64-70.

Balabanlı C, Albayrak S, Türk M, Yüksel O (2010). a research on determination of hay yields and silage qualities of some vetch plus cereal mixtures. *Turkish Journal of Field Crops* 15(2): 204-209.

Başaran U, Gülümser E, Mut H, ÇopurDoğrusöz M (2018). Determination of silage yield and quality of damson + cereal mixtures. *Turkish Journal of Agriculture-Food Science and Technology* 6(9): 1237-1242.

Ceyhan E, Karadaş S (2023). Forage pea pure lines: Winter hardiness, high seed and biological yield. *Selcuk Journal of Agriculture and Food Sciences* 37 (3): 487–496.

Ceyhan E, Kahraman A, Ates MK, Karadaş S (2012). Stability analysis on seed yield and its components in peas. *Bulgarian Journal of Agricultural Science*, 18 (6): 887-893.

Eğritaş Ö, ÖnalAşcı Ö (2017). Determination of some mineral matter content of common vetch-grain mixtures. *Academic Journal of Agriculture* 4(1): 13-18.

Elçi S (1975). Vetch (*Vicia*) agriculture. Food, Agriculture and Livestock Presidency, General Directorate of Agriculture Publications no: D- 167, Ankara.

Erbil IN (2012). The effects of homofermentative and/or heterofermentative lactic acid bacteria inoculants on the fermentation, and aerobic stability characteristics of hungarian vetch-wheat silages. Master's Thesis, Namık Kemal University (unpublished), Türkiye.

Filya İ (2002). Effects of lactic acid bacteria and lactic acid bacteria+enzyme mixture silage inoculants on corn silage. *Turkish Journal of Veterinary and Animal Sciences* 26: 679-687.

Gomes ALM, Jacovaci F, A, Bolson DC, Nussio LG, Jobim CC, Daniel JLP (2019). Effects of light wilting and heterolactic inoculant on the formation of volatile organic compounds, fermentative losses and aerobic stability of oat silage. *Animal Feed Science and Technology* 247: 194-198.

Görü N, Seydoşoğlu S (2021). Determination of silage quality characteristics in mixtures of some cool climate cereals (oat, barley, rye and triticale) with common vetch at different ratios. *Journal of Faculty of Agriculture, Isparta University of Applied Sciences* 16(1): 26-33.

Gümüştaş M, Turan N (2022). Investigation of the effect of some cereals mixed with forage pea (*Pisum sativum* l.) at different ratios on silage quality. *Ispec Journal of Agricultural Sciences* 6(1): 118-130.

Jang WS, Yang BM, Heo JM, Lee HS, Lee SK (2015). Effects of supplementation of hairy vetch on the quality of whole crop barley silage. *Korean Journal of Agricultural Science* 42(4): 383-388.

Karadeniz E, Eren A, Saruhan V (2020). Determination of silage quality of damson (*Lathyrus sativus* L.) and triticale (X *triticosecale* Wittmack) mixtures. *Ispec Journal of Agricultural Sciences* 4(2): 114-124.

Kavut YT, Soya H, Geren H, Ünsal R, Sevim İ, Avcıoğlu R (2012). Research on silage yield and silage quality characteristics of some triticale varieties grown under Menemen conditions. *Ege University Faculty of Agriculture Anatolian Aegean Agricultural Research Institute Journal* 22(1): 33-44.

Kaymak G, Gülümser E, Can M, Acar Z, Ayan İ. (2021). Determination of silage quality of leafy and semi-leafy forage pea varieties and annual grass mixtures. *Journal of Iğdır University Institute of Science and Technology* 11(2): 1595-1602.

Keleş G, Alataş MS, Ateş S. (2013). Nutrient value and fermentation characteristics of alfalfa and hungarian vetch silages ensiled with silage additives. *VII. National Animal Nutrition Congress*, September 26-27, 2013 Ankara, Türkiye.

Kidambi SP, Matches AG, Gricgs TC (1989). Variability for ca,mg,k,cu,zn and k/(ca+mg) ratioamong 3 wheat grasses and sainfoin on thes out hern high plains. *Journal of Range Management* 42(2): 316-322.

Kidambi SP, Matches AG, Karnezos TP, Keeling JW (1993). Mineral concentrations in forage sorghum grown under two harvest management systems. *Agronomy Journal* 85(4): 826-833.

Marković J, Blagojević M, Kostić I, Vasić T, Anđelković S, Petrović M, Štrbanović R (2018). Effect of bacterial inoculants application and seeding rate on common vetch-oat silage quality. *Biotechnology in Animal Husbandry* 34(2): 251-257.

Mut H, Gülümser E, Çopur Doğrusöz M, Başaran U (2020). The effect of different companion plants on alfalfa silage quality. *Ksü Journal of Agriculture and Nature* 23(4): 975-980.

Paydaş M (2018). Determination of quality, nutrient composition and digestion of silages obtained from a mixture of barley and vetch plants harvested at different periods. Master's Thesis, Harran University (unpublished), Türkiye.

Panyasak A, Tumwasorn S. (2013). Effect of Moisture Content and Storage Time on Sweet Corn Waste Silage Quality. Department of Animal Science, Faculty of Agriculture, Kasetsart University, Bangkok 10900, Thailand. *Agricultural Technology and Biological Sciences*, Walailak J Sci & Tech 2015; 12(3): 237-243

Polat M (2022). Determination of silage quality of different mixtures of forage pea (*PisumSativum* L.) and oat (*Avena Sativa* L.) in Şanlıurfa province. Master's Thesis, Harran University (unpublished), Türkiye.

Romero JJ, Zhao Y, Balseca-Paredes MA, Tiezzi F, Gutierrez-Rodriguez E, Castillo MS (2017). Laboratory silo type and inoculation effects on nutritional composition, fermentation, and bacterial and fungal communities of oat silage. *Journal of Dairy Science* 100(3): 1812-1828.

Tekeli AS, Ateş E (2005). Yield potential and mineral composition of white clover (*Trifolium Repens* L.)-tall fescue (*Festuca Arundinacea* Schreb.) mixtures. *Journal of Central European Agriculture* 6(1):27-34.

Turan N (2018). Determination of the effect of different mixing ratios of Hungarian vetch and wheat grown in the ecological conditions of Eastern Anatolia region on silage quality. *Siirt University, Engineering and Natural Sciences* 12: 99-107.

Yavuz H (2022). Determination of silage quality of different mixtures of forage pea (*Pisum sativum* l.) and barley (*Hordeum Vulgare* L.) in Şanlıurfa province. Master's Thesis, Harran University (unpublished), Türkiye.

Yildirim F (2020). Determination of yield and yield components and some silage properties of some annual legume forage crops. *ISPECC Journal of Agricultural Sciences* 4(3): 477-491.