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Determination of Silage Quality of Different Mixtures of Narbon vetch (*Vicia narbonensis*) and Italian Ryegrass (*Lolium multiflorum*) in Şanlıurfa Province of Türkiye

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ABSTRACT

Background: This research was carried out to determine the silage quality of mixtures of Narbon vetch (*Vicia narbonensis*) + Italian ryegrass (*Lolium multiflorum*) planted at different ratios (100:0, 75:25, 50:50 and 25:75) in Şanliurfa province of Türkiye.

Methods: The study was carried out in 2022 at Harran University Agricultural Research and Application Area, according to the randomized block trial plan with 4 replications. In the research, quality criteria such as pH value, dry matter ratio, ADF, NDF, crude protein ratio, raw ash ratio, silage odour, structure, colour and Flieg score of silage were determined by labouratory analyses.

Result: The highest pH value (5.65) was obtained from 50:50 mixture ratio and the lowest pH value (5.22) was obtained from pure Italian ryegrass. The highest dry matter ratio (35.75%) was obtained from 50:50 mixture and the lowest dry matter ratio (31.07%) was obtained from 25:75 Narbon vetch and Italian ryegrass mixture. The highest ADF value (25.0%) was obtained from pure Italian ryegrass and the lowest ADF value (22.9%) was obtained from 75:25 Narbon vetch and Italian ryegrass mixture with. The highest NDF value (44.8%) was obtained from pure Italian ryegrass and the lowest NDF value (29.3%) was obtained from 75:25 Narbon vetch and Italian ryegrass mixture. The highest crude ash value (12.7%) was obtained from pure Italian ryegrass, the lowest crude ash value (8.2%) was obtained from 50:50 mixture. The highest crude protein value (35.7%) was obtained from 50:50 mixture and the lowest crude protein (27.0%) was obtained from pure Italian ryegrass. It was determined that the 75:25 mixture of Narbon vetch + Italian ryegrass was the most suitable option in terms of digestive efficiency and energy use.

Key words: *Lolium multiflorum*, Mixture, Quality, Silage, *Vicia narbonensis*.

INTRODUCTION

An annual leguminous that was domesticated in the early years of agriculture is Narbon vetch (*Vicia narbonensis* L.). Originating in North-West Asia, it then spread to the Mediterranean Basin and gained popularity in Australia. In regions with low to moderate rainfall, it is utilised as a multipurpose legume for green manure, grain, hay, silage and green fodder. A promising forage legume, Narbon vetch exhibits strong resistance to pests, cold and drought. The green sections of the plant are either harvested for hay, grazed, or utilised as fodder (El-Bok, 2017). Vicia narbonensis is a cool-season, drought-tolerant plant that thrives in regions with low winter temperatures and 250-300 mm of annual rainfall (Ahmadi *et al.,* 2024). Narbon vetch grows fast and re-grows vigorously. It is quite similar to broad bean. In Syria, northern Iraq and some regions of Turkey, it is cultivated as a crop that may be used for both human food and animal feed. It is available in every region of Türkiye except Northeast Anatolia (Bakoglu *et al.,* 2016).

Globally, two varieties of ryegrass are being grown: annual and perennial. The herbaceous annual or biennial Italian ryegrass (*Lolium multiflorum*) is cultivated as a cover crop and for silage. It grows on around 1 million hectares in the humid southern United States, mostly in the USA. It is mostly used for winter grazing in clear seeding and in dormant Bermudagrass sods (Liu *et al.,* 2020). Italian ryegrass is used extensively for silage production in temperate regions because of its high yield, digestibility and nutritional value-particularly its highly soluble and degradable nitrogen and carbohydrates (Stergiadis *et al.,* 2015). The development stage of Italian ryegrass during harvest has a significant impact on its utilization efficiency because it is the primary element influencing the forage's nutritional value and digestibility (Yin *et al.,* 2023).

Ensiling is a common technique used to preserve the nutritional value of fodder and guarantee a steady supply of feed to meet animal production requirements throughout the year (Souza *et al.,* 2022). Despite having a high

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percentage of crude protein (CP), the species, cultivar, harvest date and environmental and management factors all affect the legumes' bromatological characteristics and, consequently, their appropriateness for ensilement (Mariotti *et al.,* 2018). Additionally, compared to cereals, legume forages contain a lower proportion of neutral detergent fibre (NDF) and more fragile NDF fragments, which translate into a larger dry matter intake-a desirable characteristic (Eskandari *et al.,* 2009). Despite these advantageous traits, legume crops are challenging to ensile due to their low WSC content, high buffering capacity and low DM and moisture content (Angeletti *et al.,* 2022). The low CP content of cereal forages typically restricts their forage values and this is typically eliminated by providing proteins from other sources (Eskandari *et al.,* 2009). Thus, combining cereals and legumes can be an effective way to provide high-quality fodder, particularly for the preparation of silages. However, the ratio of the crops in the combinations can affect the silages' dry matter, CP and pH (Angeletti *et al.,* 2022).

This study was carried out to determine the silage quality of Narbon vetch (*Vicia narbonensis* cv. Özgen) and ryegrass (*Lolium multiflorum* cv. Efe-82) mixtures at ratio of 100:0, 75:25, 50:50 and 25:75.

MATERIALS AND METHODS

This research was carried out in Sanliurfa province of Turkiye in Harran University, Faculty of Agriculture, Osmanbey Campus Agricultural Research and Application Area, during 2022 winter growing season. Efe-82 Italian ryegrass and Özgen Narbon vetch varieties were used in the research. The seeds of the varieties were supplied by Sanliurfa GAPTAEM (GAP Agricultural Research Institute, Sanliurfa, Turkey). The Climatic data for the experimental year and the long-term averages can be seen below (Table 1).

The test field was flat and soil was deep, heavy clay textured, highly calcareous, cracking in summer under dry conditions. The entire profile was calcareous, pH is between 7.4-7.6, salt content was very low, the cation exchange capacity was high and the Na content was low (Table 2).

The research was carried out in randomized complete blocks design with 4 replications during the winter growing season, sown in the third week of November. The experimental soil was deeply plowed and then mixed with a cultivator for weed management. Before planting, a harrow was pulled and the soil was prepared. Planting was completed manually by hand in the lines opened with markers at a depth of 2-3 cm. Each experimental plot was at 20 cm interrow distance, 5 metres long with 4 plant rows ($0.20 \times 5 \times 4 = 4$ m^2). Efe-82 Italian ryegrass variety and Özgen Narbon vetch variety were used in the experiment. Seeding rates were 1) pure Narbon vetch, 2) pure Italian ryegrass, 3) 75:25 Narbon vetch and Italian ryegrass mixture, 4) 50:50 Narbon vetch and Italian ryegrass mixture, 5) 25:75 Narbon vetch and Italian ryegrass mixture. During soil preparation, 20.20.0 compound fertilizer was applied in the trial area (40 kg/ha pure N and 40 kg/ha pure P_2O_5). Immediately after the sowing process, irrigation was carried out with a sprinkler system twice for 5 hours at three-day intervals.

Harvest was accomplished when the lower pods were formed for the Narbon vetch and in the milk stage maturity period for the Italian ryegrass and mixtures. The edge rows of the plots and 50 cm of the row ends were discarded and the remaining parts were harvested ($0.20 \times 4 \times 2=1.6$ m^2). Measurements and observations of the characters were made in this determined area.

Pod formation on plants and preservation of plants in jars for experimental silage production can be seen below (Fig 1).

The pH value of the silage was measured with a pH metre after adding 90 ml of water to 10 g of silage samples and mixing them homogeneously. For DM, 100 g of samples were taken from the silages in the jars and dried in the oven at 70°C for 24 hours. After the drying process was completed, the dry matter ratio was determined by weighing them on a precision scale. The total amount of lignin, hemicellulose and cellulose in the dried plants used as material was determined with the ADF, NDF unit of the (Ankom 220 Fiber System) reported by Seydosoglu, (2019). After the dried samples were ground, they were passed through 1 mm sieves, the N ratio was determined by the Kjeldahl method and the crude protein ratio was calculated by multiplying by 6.25. For the raw ash ratio (%), 0.5 g samples were sieved through 1 mm sieves and left in their crucibles and burned in the ash oven at 550°C for 4 hours until it turned light gray and calculated by proportioning.

Table 1: Trial year (2022) and long-term climate data averages.

Months	Max temperature (°C)	Min temperature (°C)	Avg. temperature (°C)	Relative humidity (%)	Total precipitation (mm)
November/Long term	21.8/18.7	10.0/8.4	14.8/12.1	42.3/63.5	6.7/44.9
December/Long term	12.8/12.0	6.3/3.9	9.0/7.5	79.4/69.1	277.7/80.1
January/Long term	10.8/9.80	3.4/2.0	6.6/5.5	69.1/71.5	76.9/87.6
February/Long term	11.9/12.0	3.0/2.8	7.0/7.1	63.4/67.7	24.1/69.5
March/Long term	19.1/16.4	8.8/5.7	13.3/10.8	63.6/64.4	90.8/62.8
April/Long term	23.9/22.2	11.2/10.2	17.1/16.2	54.2/62.8	68.3/48.8
May/Long term	30.4/28.6	16.2/15.2	23.2/22.1	41.1/54.0	39.1/26.7

Structure, colour and odour factors were examined in determining the physical qualities of silage. Silages made in different proportions were opened and then physical evaluation was carried out. In physical evaluations, points were given to the colour, smell and structures of silages, then the values obtained were collected, the obtained points were between 0 and 20 (Kılıç, 1986). The score was as follows: Very good (18-20), Good (14-17), Medium (10-13), Weak (5-9), Bad (0-4).

"Fleig point= 220 + (2 x % k. m - 15)-40 × pH)" formula was used for calculations of Fleig points. The scoring was as follows: Very good (81-100), Good (61-80), Satisfactory (41-60), Moderate (21-40), Bad (0-20) (Kılıç, 1986).

The existing colour, smell and structure in the silage were scored by the silage evaluation key (DLG, German Agricultural Organization) reported by Alcicek and Ozkan (1997).

RESULTS AND DISCUSSION

Physical observations

The physical observation results and quality class values of silages of Narbon vetch and Italian ryegrass mixtures are given in Table 3.

There are significant differences in total physical score (DLG) and quality class between the applications. For example, pure Narbon vetch and 2″5% Italian ryegrass +75% Narbon vetch" achieved the highest total physical scores (16.2) and positioned in ″good″ quality class. This shows that these combinations have a positive effect. "75% Italian ryegrass + 25% Narbon vetch" and "50% Italian ryegrass + 50% Narbon vetch" applications were in the ″medium″ quality class due to their lower total physical scores. This situation shows that the mixing ratios have a significant effect on the quality.

The odour values were between 7.0 and 12.0. The applications of pure Narbon vetch and "25% Italian ryegrass + 75% Narbon vetch", which have the highest odour value, were also in the highest quality class. This may suggest that smell can have a significant impact on quality. It has been observed that the external appearance (structure) scores vary between 2.0 and 3.5. Silage colour scores were low. Although the colour scores were low, it was seen that high odour scores are more decisive on the overall quality. According to the results, total physical score must be 14.2 and above in order to be in the good quality class.

Pure Narbon vetch and "25% Italian ryegrass + 75% Narbon vetch" have given best results in terms of quality. It was observed that the mixture ratios significantly affected the quality. In particular, the decisive effect of smell on quality has attracted attention.

The external appearance (structure) scores ranged between 2.0 and 3.5. The pure Italian ryegrass had the highest value. It was observed that silages obtained from Narbon vetch and Italian ryegrass mixtures do not differ in terms of total physical score and silages were in the very good quality class.

Mut *et al.* (2020) determined silage quality traits of Narbon vetch + ryegrass mixtures (at ratios of 100:0, 80:20, 60:40, 40:60 and 20:80) and according to the Flieg scores, sole ryegrass silage (93.91), "60% Narbon vetch + 40% ryegrass" (94.69), "40% Narbon vetch +60% ryegrass" (87.87) and "20% Narbon vetch + 80% ryegrass" (94.51) silages were at highest value and in good quality class.

The mixture ratios were significantly effective on the pH values (Table 4).

Table 2: Soil properties of the experimental area (GAPTAEM).

Soil properties	Soil analysis results
Isba (%)	63
EC2510^3 mmohs/cm	1.00
pH	7.59
Limestone (%)	32.3
P_2O_5 (kg/da)	4.29
K_2O (kg/da)	64.8
Organic matter (%)	1.00
N (%)	0.05
Cu (mg/kg)	1.70
Mn (mg/kg)	21.82
Fe (mg/kg)	8.03
Zn (mg/kg)	0.35



Fig 1: Pod formation in plants (left) and preservation of plants in jars for silage (right).

pH, DM, ADF, NDF, CP and dry ash values

While pure Italian ryegrass provides the best fermentation, increasing the ratio of Narbon vetch has increased the pH values and decreased the fermentation quality. For this reason, a better fermentation can be achieved by optimizing the Narbon vetch ratio.

There was a strong effect of the mixtures on the dry matter content. Narbon vetch + Italian ryegrass (50:50) was at the highest dry matter ratio (35.7%). This mixture can offer an ideal composition for increasing the dry matter ratio of silage. Statistically, it is significantly different from all other mixtures. Narbon vetch + Italian ryegrass 25:75 mixture was at the lowest dry matter ratio (31.1%).

DM content of raw materials has a great influence on silage fermentation, which affects all fermentation characteristics, pH level and quality parametre of silage. Ensiling with low DM content around 25% could cause inferior fermentation and high pH level deducing serious DM loss, compared with higher DM content. At less than 300 g/DM kg may also generate an increase in seepage loss and expedite clostridial fermentation reducing voluntary intake. But wilting reduces the amount of fermentable carbohydrate required to properly preserve the silage and restricts the growth of undesirable microorganism (Liu *et al.,* 2020).

Sole Italian ryegrass forage crop silage DM contents were between 32.3-40.6% in the study of Gürsoy *et al.* (2022). Sole Italian ryegrass forage crop silage DM values were between 38.7-58.6% in the study of Assouma and Çelen, (2022).

The mixture ratios have no significant effect on the ADF ratios.

The mixing ratios formed statistically significant differences on NDF. The NDF ratio of pure Italian ryegrass was 44.7%; the highest NDF rate. Since Italian ryegrass is a material rich in structural fibre, a high NDF ratio was expected. This can negatively affect digestibility. The NDF ratio of Narbon vetch + Italian ryegrass (75:25) was 29.3%; the lowest NDF rate. This may indicate that the fibre content decreases with high consumption of whole Gramineae. This mixture may be advantageous in terms of digestibility. As the ratio of Narbon vetch increases, the NDF ratio decreases, while the ratio of Italian grass increases. It offers a balanced profile compared to other mixtures in terms of digestibility.

Turan, (2020) determined the quality and chemical composition of silages obtained by mixing in different ratios of Narbon vetch (*Vicia narbonensis* L.) and barley (*Hordeum vulgare* L.) (mixtures of 20, 30, 40, 50, 60, 70, 80% of Narbon vetch + 80, 70, 60, 50, 40, 30, 20% of barley) grown in Eastern Anatolia, Turkey. The ADF and NDF values of silages were respectively 33.38 and 33.73.

Sole Italian ryegrass forage crop silage ADF ratios were between 39.4-46.3% in the study of Gürsoy *et al.* (2022). Sole Italian ryegrass forage crop silage NDF ratios were between 63.1-72.5% in the study of Gürsoy *et al.* (2022).

Sole Italian ryegrass forage crop silage NDF values were between 61.2-65.4% in the study of Ertekin *et al.* (2021). Sole Italian ryegrass forage crop silage ADF values were between 36.0-38.0% in the study of Ertekin *et al.* (2021).

Sole Italian ryegrass forage crop silage NDF values were between 45.3-61.1% in the study of Assouma and Çelen, (2022). Sole Italian ryegrass forage crop silage ADF

Table 3: The physical observation results and quality class values of silages of Narbon vetch and Italian ryegrass mixtures.

Applications	Odor	Appearance (Structure)	Silage color	Total physical score (DLG)	Quality class
%100 Narbon vetch	12.0	3.0	1.2	16.2	Good
%100 Italian ryegrass	9.5	3.5	1.2	14.2	Good
%75 Italian ryegrass + %25 Narbon vetch	10.0	2.0	1.0	13.0	Medium
%50 Italian ryegrass + %50 Narbonvetch	7.0	3.0	1.7	11.7	Medium
%25 Italian ryegrass + %75 Narbon vetch	12.0	3.0e	1.2	16.2	Good

Table 4: pH, DM, ADF, NDF, CP and dry ash averages and groups of Italian ryegrass and Narbon vetch mixtures.

Mixtures	pH	DM (%)	ADF (%)	NDF (%)	CP (%)	Dry ash (%)
%100 Narbon vetch	5.51ab	33.5c	23.4a	40.2ab	27.7bc	8.26sl
%100 Italian ryegrass	5.22c	34.9b	25.0a	44.8a	26.9c	12.69sl
%75 Italian ryegrass + %25 Narbon vetch	5.31bc	31.1d	23.0a	37.2b	29.9ab	8.16sl
%50 Italian ryegrass + %50 Narbon vetch	5.65a	35.7a	23.4a	40.3a	35.7a	8.20sl
%25 Italian ryegrass + %75 Narbon vetch	5.27bc	31.4d	22.9a	29.3c	31.0a	8.24sl
Averages	5.4	33.3	28.7	38.3	30.3	9.11
LSD (%5)	0.27	0.64	4.26	4.26	0.64	6.16

Letters such as a, ab, b, bc, d are used to indicate statistical groupings based on post-hoc multiple comparison test (LSD) sl-significant level.

values were between 27.7-38.0% in the study of Assouma and Çelen, (2022).

Pure Italian ryegrass mixture (12.7%) was at the highest level of crude ash ratio. This value was especially noteworthy compared to other mixtures and suggests that the nutritional value may be more intense. The overall average crude ash content was 9.11%. Pure Italian ryegrass was above this average, while other mixtures remain below the average.

Pure Italian ryegrass attracts attention with its high crude ash ratio. This may indicate that it can provide more dry matter when used as animal feed and therefore be more nutritious. Even if the proportions of the Narbon vetch were changed in the mixtures, there were no major changes in the raw ash ratios. This may indicate that the Narbon vetch plays a balancing role in the mixtures. Although pure Narbon vetch has a low crude ash ratio, this value has not changed in other mixture. This may indicate that the juiciness rate of the big vetch may be higher.

Sole Italian ryegrass forage crop silage ash values were between 11.7-13.1% in the study of Ertekin *et al.,* (2021). Sole Italian ryegrass forage crop silage crude ash values were between 8.3-13.2% in the study of Assouma and Çelen, (2022).

It can be considered that the composition of the mixtures significantly affects the crude protein content. Results suggest that the material ratios used in silage should be optimized. Materials with a high protein content should be added to the mixture. Legumes are rich in protein content and can increase the protein values of silage. Protein density can be increased by reducing the proportion of Italian ryegrass.

Mut *et al.,* (2020) determined silage quality traits of Narbon vetch "NV" (*Vicia narbonensis* L.) and ryegrass "R" (*Lolium multiflorum* L.) mixtures (100:0, 80:20, 60:40, 40:60 and 20:80%). The highest crude protein content was determined in sole Narbon vetch (16.13%), 80NV+20R% (14.77%) and 60NV+40R% (14.27%).

Turan, (2020) determined the quality and chemical composition of silages obtained by mixing in different ratios of Narbon vetch (*Vicia narbonensis* L.) and barley (*Hordeum vulgare* L.) (mixtures of 20, 30, 40, 50, 60, 70, 80% of Narbon vetch + 80, 70, 60, 50, 40, 30, 20% of barley) grown in Eastern Anatolia, Turkey. The CP values of silages were respectively 33.38, 33.73, 15.50%.

Sole Italian ryegrass forage crop silage CP contents were between 10.2-29.5% in the study of Gürsoy *et al.* (2022). Sole Italian ryegrass forage crop silage pH values were between 5.99-6.06 in the study of Ertekin *et al.* (2021). Sole Italian ryegrass forage crop silage CP values were between 8.5-14.5% in the study of Ertekin *et al.* (2021). Sole Italian ryegrass forage crop silage CP values were between 3.38-10.49% in the study of Assouma and Çelen, (2022).

CONCLUSION

The mixture ratios significantly affected pH values, with pure Italian ryegrass showing the best fermentation. Increasing Narbon vetch proportion raised pH and lowered fermentation quality. Dry matter content averaged 9.11%, with no significant differences between mixtures. The highest crude protein (31.0%) was found in a mixture containing 75% Narbon vetch, while pure Italian ryegrass had the highest mineral content.

Mixtures with lower ADF and NDF ratios, such as 75% Narbon vetch + 25% Italian ryegrass or pure Narbon vetch, improved digestibility and feeding efficiency. For high protein needs, higher Narbon vetch ratios are recommended. Although pure Italian ryegrass is mineral-rich, its high fibre content may reduce digestibility.

Overall, the 75:25 Narbon vetch and Italian ryegrass mixture balanced digestibility, energy use and nutrition best. Choice of mixture should consider specific feeding goals and local conditions.

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Informed consent

Because a significant contribution to the research was made by the supervisor. The authors have agreed to list the supervisor's name (Gülsah Bengisu) first in the order of authorship, with the student's consent.

Conflict of interest

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