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Determination of Quality and Chemical Composition of Silages Obtained from Narbonne Vetch (*Vicia narbonensis*) and Barley (*Hordeum vulgare*) Composition

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ABSTRACT

Research was conducted to determine the quality and chemical composition of silages obtained by mixing in different ratios of narbonne vetch (*Vicia narbonensis* L.) and barley (*Hordeum vulgare* L.) grown in *rabi* season of 2017-2018 in Eastern Anatolia, Turkey. In the study we studied the pure sowings of barley and narbonne vetch and their mixtures (20, 30, 40, 50, 60, 70, 80% of narbonne vetch (N) + 80, 70, 60, 50, 40, 30, 20% of barley (B). The values of ADF (acid detergent fiber), NDF (neutral detergent fiber), DDM (digestible dry matter), DMI (dry matter intake), DM (dry matter), CP (crude protein) and RFV (relative feed value) of silages of analyzed were respectively 33.38, 33.73, 62.89, 3.57, 24.69, 15.50%, 174.64. We also founded that LA (lactic acid), AA (acetic acid), BA (butyric acid), PA (propionic acid) and Ca, P, Mg, K and pH of silages investigated were respectively 1.60, 0.57, 0.42, 0.06, 1.17, 0.53, 0.25, 3.51% and 3.80. Our results shows that silages with high narbonne vetch were higher quality values for CP, ADF, NDF, DM, RFV, DDM, DMI, Ca, Mg, LA which determined chemical composition and feeding quality of silages. As a result, it is suggested that mixture silages with narbonne vetch (80%) and the barley ratio (20%) have important advantages for some properties of silages.

Key words: Cereal, Chemical composition, Legume, Mixture, Quality, Silage.

INTRODUCTION

Eastern Anatolia Region of Turkey under the influence of terrestrial climate conditions it is cold and snowy in winter season, while it is hot and dry in summer season. At the same time, the pasture areas of this region which has an important potential in terms of animal breeding have decreased considerably as a result of excessive and uncontrolled grazing. Thus, degradation of the pastures and a significant decrease in the quality roughage production was common issue (Seydosoglu and Kokten, 2019). Accordingly, a shortage of quality roughage presents a serious problem to animal husbandry in the region. Therefore, livestock are fed predominantly cereal chaff and straw, which have low nutritional values and are used as filler material to keep livestock from feeling hungry. However, in order to obtain animal products, milk, meat *etc*., from the livestock in desired levels, they should be fed with quality roughage obtained from forage crop species. To meet the current requirements for quality roughage of the expanding livestock population in Eastern Anatolia Region of Turkey, it is of great importance to determine suitable forage crop for silage making. This deficit for roughage production in Turkey can be solved by increasing silage production from pasture grasses, legume and wheat forage plants mixture or corn in the vegetation periods when green and juicy feeds are abundant. However, corn from these forage plants mentioned is a hot season plant and requires a safe period of at least three months of frost for successful cultivation. Therefore, it is possible to grow narbonne vetch with high yields as a winter vetch in Eastern Anatolia conditions, which it is relatively resistant to cold and drought when compared to other vetch. Moreover, narbonne vetch is a one-year legume forage plant. At the same time, it has been reported that it is good for properties of silage. Even, narbonne vetch can be harvested without watering in winter sowings (Cacan and Kokten, 2017; Seydosoglu and Kokten, 2019).

In this study, it was aimed to determining of quality and chemical composition of silages obtained from narbonne vetch (*Vicia narbonensis*) and barley (*Hordeum vulgare*) at different levels of mixture and thus to detect the best mixture ones.

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MATERIALS AND METHODS

This study was conducted for one year (2017-2018) in winter season at Mus city located at the Eastern Anatolia region, Turkey (706100-706300 N, 7307800-7307950 E and altitude 1350 m) (Fig 1). As in barley, the narbonne vetch was sown in winter season. The average rainfall for many years in Mus province was 745.02 mm, the relative humidity was

61.99% and the temperature was 8.10°C. The soil structure of area conducted at the experiment was neutral, calcareous, salt-free and organic matter was low and also, the amount of phosphor is poor and potassium is sufficient. According to the soil analysis, the experimental area soils had a clay-loan structure and were brown in color. Moreover, the soils were rich in terms of calcium (1.58%) and potassium (209.99 ppm K_2O) contents, whereas organic matter (1.14 %) and phosphorus (26.3 kg ha^{-1} P_2O_5) contents were relatively low. Also, due to the high limestone content, the pH status of the soils was neutral.

Sowing of crops was done on 05.11.2017 and each crops planted in 0.004 ha separately by maintaining seed rate of 200 kg ha^{-1} of barley and wheat and 100 kg ha^{-1} of narbonne vetch crop. At the same time, 150 kg ha^{-1} of DAP fertilizer (27 kg ha^{-1} N, 69 ha^{-1} P) were applied to barley during sowing; whereas it was 100 kg ha^{-1} DAP (18 kg ha^{-1} N, 46 ha^{-1} P) for narbonne vetch.

Harvests were made in at full bloom for narbonne vetch, at milking stage for barley. The plots were separately harvested with hand sickle. After the harvesting, material of silage were faded in the shade for 3-4 hours and then cut into 0.5-1 cm dimensions with a silage harvester working with the tail shaft. After the chopping process, the materials were weighed on the sensitive scale according to the standardized rates.

The materials weighed were filled homogeneously and filled in 2 liter plastic jars with 3 replications. The jars filled with silage materials are hand-tightened thoroughly. After the lid of the jars is closed tightly, they are wrapped with duct tape so that they do not breathe. It was then allowed to ferment into the dark environment for 60 days. At the end of this period, the maturing silages were opened and after the 4-5 cm part of the mouth of the jars were removed; the pH values were measured (Polan *et al*., 1998). After weighing 500 g of silage from each jar, it was dried to a constant weight for 48 hours (AOAC, 1990) at 60°C. After the dry weight of the silages was obtained, the samples were ground and prepared for analysis.

The content of crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF) and mineral of the silages was analyzed with Near Infrared Reflectance Spectroscopy (NIRS) and Near Infrared Analysis (NIR) by spectroscopic technique (Hoy *et al.*, 2002), while organic acid ratios analyzed in this study were detected with HPLS (Canale *et al*., 1984).

The data obtained were analyzed to variance analysis by using JUMP program based on 5% and 1% of significance levels (SAS, 1998).

RESULTS AND DISCUSSION

The content of ADF, NDF, DDM, DMI, RFV and DM of silages

The ADF, NDF, DDM, DMI, RFV and DM ratios of silage obtained from different mixing ratios of narbonne vetch and barley and differences between mixture groups were statistically significant at $p<0.01$ level (Table 1).

ADF and NDF ratio

The average ADF and NDF ratios for all silages was respectively 33.38% and 33.73%. The rations of ADF and NDF of the pure and mixture groups ratios ranged between 26.52-36.98%; 30.11-36.89%, respectively (Table 1). According to the quality standards of mixtures of legume and grains (Rohweder *et al*., 1978), the average ADF ratio of silage obtained from mixtures of barley with narbonne vetch was in 1st quality class, whereas NDF was in the top quality class. Compared with studies performed for ADF ration of silages, it observed that our findings were in accordance with results reported by some of studies (Bergen *et al.*, 1991; Aykan and Saruhan, 2018), whereas it was lower than the results reported by Aykan and Saruhan (2018). It was thought that plant material, harvest periods, mixture ratios and ecological conditions can lead to such differences.

DDM (digestible dry matter) ratio

The average DDM ratio of pure and mixed silages was 62.89%. The highest DDM ratio was obtained from narbonne vetch (68.24%) and pure barley (66.64%) silages in the same group. The lowest DDM ratio was obtained from N 50% + B 50% mixture silage (Table 1). Rohweder *et al.* (1978) in terms of average DDM ratio according to the quality classification of the quality was in the 1st quality class.

DMI (dry matter intake) ratio

The average DMI ratio of silages was 3.57%. The maximum DMI ratio was observed with 100% N and N 80% + B 20% silage group. However, minimum DMI was found in N 30% + B 70% and N 20% + B 80% mixture silage groups. These silages was classified as prime (best quality) (Table 1).

RFV (relative feed value)

The average RFV in this study was 174.64 for pure and mixture silages. The RFV ration was highest in N 100% silage, whereas it was lowest in N 20% + B 80% mixture silage (Table 1). For RFV it was in the prime quality class (Rohweder *et al.*, 1978).

DM (dry matter) ratio

The average DM ratio of silages was 24.69%. The highest dry matter ratio of silages was obtained from pure barley silage with 28.78%. The lowest dry matter ratio was found in mixture silages N 80% + B 20%, N 60% + B 40%, N 50% + B 50% and N 40% + B 60%, but the differences between these mixture silages was not statistically significant (Table 1). The findings obtained for dry matter were contrasted the results reported by Basaran *et al.* (2018) and Aykan and Saruhan (2018).

The average Ca, P, Mg, K and CP of the silages analyzed in this study were 1.17%, 0.53%, 0.25%, 3.51% and 15.50%, respectively. The highest Ca and Mg content was detected in N 100% and N 80% + B 20% mixture silage, while the highest phosphorus P was in the pure barley

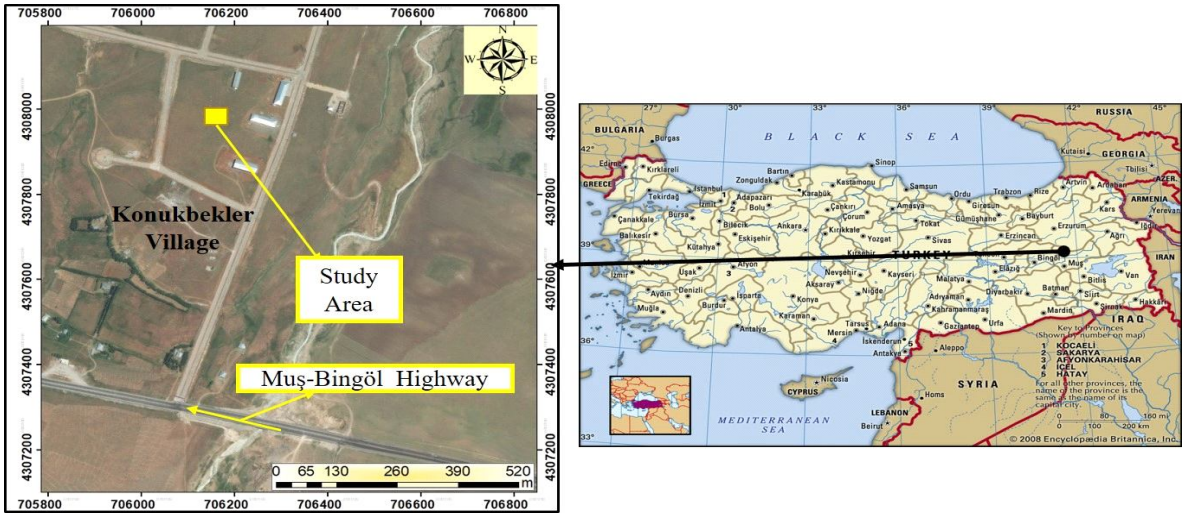

Fig 1: Location map of the study area.

Table 1: Mean values of some quality properties of silages and formed groups.

Mixtures	ADF (%)	NDF (%)	DDM (%)	DMI (%)	RFV	DM (%)
N 100%	26.52^{c}	30.11^{d}	68.24^{a}	3.99^{a}	210.82^{a}	23.56^{d}
B 100%	28.58^{c}	32.92^{bc}	66.64^{a}	3.65^{bc}	188.66^{b}	28.78^{a}
N 80% + B 20%	33.96^{b}	31.33^{cd}	62.44^{b}	3.83^{ab}	185.53^{bc}	24.00^{d}
N 70% + B 30%	34.72^{ab}	34.44^{ab}	61.85^{bc}	3.49^{cd}	167.09^{de}	24.22^{cd}
N 60% + B 40%	34.78^{ab}	32.95^{bc}	61.80^{bc}	3.65^{bc}	175.02^{b-d}	23.33^{d}
N 50% + B 50%	36.98^{a}	34.93^{ab}	60.09^{c}	3.44^{cd}	160.23^{de}	23.33^{d}
N 40% + B 60%	35.25^{ab}	33.53^{bc}	61.44^{bc}	3.59^{bc}	171.01^{c-e}	23.89^{d}
N 30% + B 70%	35.50^{ab}	36.45^{a}	61.24^{bc}	3.29^{d}	156.24^{e}	25.00^{c}
N 20% + B 80%	34.17^{b}	36.89^{a}	62.28^{b}	3.26^{d}	157.14^{e}	26.11^{b}
Mean	33.38	33.73	62.89	3.57	174.64	24.69
CV %	4.85	4.42	2.01	4.20	5.53	2.19
LSD	5.93**	5.44**	4.62**	0.57**	35.32**	1.94**

**: P<0.01 significant; ADF: Acid detergent fiber; NDF: Neutral detergent fiber; DDM: Digestible dry matter; DMI: Dry matter intake; RFV: Relative feed value; DM: Dry matter

(B 100%) and N 20% + B 80% barley silage (p<0.01). The highest K content was determined in barley silage. It is stated that animal rations should contain 0.21% P, 0.65% K, 0.31% Ca and 0.1% Mg to feed regularly and rationally (Kidambi *et al*., 1989).

When the average macro element of the silages was compared with the results reported by several studies, it can be stated that macro elements values obtained silages investigated are enough for cattle nutrition. Basaran *et al.* (2018) reported that the highest of N (2.89%), Ca (0.87%), P (0.30%) were founded in the mixture ratio of N 80% + B 20% in the mixture silages of grass pea and oat barley. However, in this experiment, it was observed that these values were higher than values reported by that study.

Further, crude protein values of silages ranged from between 9.86% and 17.08%. The average crude protein for all silages was 15.50%. The lowest crude protein content was obtained from pure barley silage, while there was an increase in crude protein content depending on increasing vetch ration in mixture silages. Our findings regarding with crude protein achieved in this study were generally in accordance with the results reported by (Aykan and Saruhan, 2018; Bengisu, 2019; Seydosoglu, 2019).

pH values of silages and organic acid contents

In the current study, there were statistically significant differences between pure and the groups of mixture silages for pH and organic acids (Table 2).

The average pH value of the silages was between 3.54-3.93 and the average pH for all silages was 3.80. The pH value of the silages varies depending on the ratio of barley in mixed silages. When the ration of barley in mixing was increase the pH of silage also increased (Table 2). According to Kilic (2006), desired pH in silage is pH between 3.5 and 4.2. Holmes (1980) reported that a quality silage can be obtained, if plants are harvested in the appropriate cutting periods. Besides, pH is varies to depend on diluting case, as well. pH in undiluted silages decrease to about 4.2, whereas it is about 4.5 in withered silages. It is important to

Table 2: Mean values of organic acid contents and values of pH of silages and formed groups.

Mixtures	pH	CP	LA	AA	BA	PA
N 100%	3.54^{f}	17.08^{a}	1.79^{a}	0.52^{cd}	0.52^{b}	0.03^{b}
B 100%	3.90^{ab}	9.86^{c}	1.69^{ab}	0.57^{bc}	0.48^{b}	0.08^{a}
N 80% + B 20%	3.74^{e}	16.83^{ab}	1.75^{a}	0.57^{bc}	0.62^{a}	0.06^{a}
N 70% + B 30%	3.74^{e}	16.80^{ab}	1.45^{c}	0.66^{a}	0.48^{b}	0.07^{a}
N 60% + B 40%	3.79^{de}	16.71^{ab}	1.47^{c}	0.61^{ab}	0.31^{c}	0.03^{b}
N 50% + B 50%	3.82^{c-e}	16.00^{ab}	1.49^{c}	0.47^{d}	0.33^{c}	0.08^{a}
N 40% + B 60%	3.85^{b-d}	15.70^{ab}	1.48^{c}	0.63^{ab}	0.25^{c}	0.06^{a}
N 30% + B 70%	3.88^{a-c}	15.41^{ab}	1.54^{bc}	0.47^{d}	0.27^{c}	0.03^{b}
N 20% + B 80%	3.93^{a}	15.16^{b}	1.73^{a}	0.68^{a}	0.50^{b}	0.06^{a}
Mean	3.80	15.50	1.60	0.57	0.42	0.06
CV (%)	1.06	6.78	5.03	0.59	1.12	2.11
LSD	0.18**	3.82**	0.32**	0.17**	0.17**	0.04**

**: P<0.01 significant; LA: Lactic acid; AA: Acetic acid; BA: Butyric acid; PA: Propionic acid; CP: Crude protein.

notice that the results of pH achieved in this study were in line with the results reported above. Again our findings were generally in accordance with the results reported by Aykan and Saruhan (2018), but it was lower than the results reported by Bergen *et al.* (1991), RFV (relative feed value), Basaran *et al.* (2018). The average LA, AA, BA, PA content of silage analyzed in the study was 1.60%, 0.5%, 0.42% and 0.06%, respectively.

It has been stated that butyric acid is not desirable in quality silage and mostly it has an average value of 0.1-0.6% (Woolford, 1984). Alcicek and Ozkan (1996) reported that there were a significant relationship between LA, AA and BA ratios and silage quality in a high quality ensiling feed. According to the authors, the LA ratio in silage is above 2%, whereas the AA ratio it should be between 0.3% and 0.7%. Additionally, Bolsen (1995 reported that the carbohydrate content of the material put into the ensiling and dry matter content should be at the level of 30-40%. At the same time, the lactic acid content in the silage should be around 5-9% of dry matter.

The results regarding with organic acids in our study were low when compared to the findings reported by studies above mentioned. However, rations of AA and BA were within the normal ranges.

The insufficiency of the ensiling plant material for the number of homo fermentative lactic acid bacteria (LAB) leads to a delay in the decrease in pH. As a result, there is an increase in nutrient loss and a decrease in the consumption of silages obtained (Woolford, 1984). For this reason, in order to increase the lactic acid content in silages consisting of vetch + wheat or vetch + barley mixtures, it is recommended to use various additives including lactic acid bacteria, especially *Lactobacillus plantarum* as a microbial additive. On the contrary, Kung *et al.* (2003) reported that the main ingredient used for legume silage in the USA is bacterial inoculants. Nonetheless there was contrast in consistence with findings reported in literature, indicating that there are difference based on type of organic acid (Bergen *et al.,* 1991; Basaran *et al.,* 2018).

CONCLUSION

In this study, we was aim to determining of quality and chemical composition of silages obtained from narbonne vetch (*Vicia narbonensis*) and barley (*Hordeum vulgare*) at different levels of mixture and thus to detect the best mixture ones. According to results of this study, as the ratio of narbonne to the mixture increases, CP, Ca and Mg content of silages increased in parallel. Moreover, we founded that in silages with high barley, contents of silages for phosphorus and potassium were higher. Furthermore, ADF and NDF ratios in silages with high vetch analyzed were low, whereas DDM, DMI ratio and RFV of these silages were higher. In fact, in forage crops, raw protein and other mineral substances of silages are required to be high, while the ADF and NDF ratios are low. Considering all above findings, it is concluded that in mixture silages, we should keep the high vetch rations and lower barley rations to achieve the high quality silage.

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