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Effects of different mixture ratios of grass pea (*Lathyrus sativus* L.) and barley (*Hordeum vulgare*) on quality of silage

Seyithan Seydosoglu*

Siirt University, Faculty of Agriculture,
Field Crops Department, Siirt, Turkey.
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ABSTRACT

The study was aimed to determine the properties of silages obtained by growing different mixture ratios of grass pea and barley harvested in the flowering and spike period, respectively. The research was carried out in the experimental field of the GAP International Agricultural Research and Training Center during 2014-2015 and 2015-2016 growth seasons during two years. "Kendal" barley variety and GAP Mavisi grass pea variety were used as material.The treatments *viz.*,100% barley, 100% grass pea, 75% grass pea + 25% barley, 50% grass pea + 50% barley and 25% grasspea + 75% barley mixtures were used for different silage preperations. Silages were prepared with 4 replications in 3 liters plastic jars, which were mixed and compressed uniformly and sealed thight. Crude protein, crude ash, acid detergent fiber, neutral detergent fiber and lactic acid ratios of silages were determined. According to 2-year average results; all applications were found statistically significant.

Key words: Barley, Grasspea, Mixture, Protein, Silage quality.

INTRODUCTION

Livestock production in Turkey largely depends on pastures. In dry months of years, grazing requirement of these animals is compensated by feeding with crop residues like wheat stubble. Low nutritioning value of these complementary feeds reduces yield of animals. For this reason, limited amount quality feed sources are required to be stored to utilise in the deficit periods. Despite all efforts in the past, the production and consumption of silage has been limited for dairy cattle production and it has not been extended to the general. In order to provide energy / protein balance, which is an important criterion for adequate and balanced nutrition of animals, it is necessary to mix legumes with gramineae. Compatibility of harvest time of gramineae and legumes is important for mixed cropping.

Further, it is more appropirate to mix these two in correct proportions to guarantee the optimum fermentation (Demirel *et al*., 2010). Baghdadi *et al*., (2016) conducted a research with maize and soybean mixture and found that increase of ratio of maize in maize-soybean mixture, negatively affected neutral detergent fiber, acid detergent fiber of forage and declined with increasingratio of soybean plants. They also found that the 50:50 maize-soybean ratio was the optimum giving highest forage yield, proteincontent and protein yield. Yucel *et al*., (2018) conducted a research with mixtures of bersem clover (*Trifolium alexandrinum* L.) with Italian ryegrass (*Lolium multiflorum* Lam.) and concluded that the mixture of 60 % bersem clover + 40 % Italian ryegrass, harvested at full flowering of bersem clover was superior in terms of dry matter yield and silage quality.

The aim of this study is to determine the effect of different barley and grass pea mixing rates on silage properties.

MATERIALS AND METHODS

Kendal barley variety and GAP Mavisi grass pea variety were used in the experiment. Both varieties were registered by GAP International Agricultural Research and Training Center. Kendal barley variety is a medium tall, erect, resistant to lodging, spring type, 6 row, mid-late variety. GAP Mavisi grass pea variety is suitable for both green and dry feed production, medium tall, blue petal colored, annual variety. The research was conducted for two years in 2014-2015 (first year) and 2015-2016 (second year) seasons, in the GAP International Agricultural Research and Training Center.

Grass pea and barley seeds were sown in seperate fields by a cereal sowing machine. 220 kg ha^{-1} barley seed were used for sowing. As base fertilizer, 27 kg ha^{-1} N and 69 kg ha^{-1} P_2O_5 were applied to each barley parcel. Barley parcels were top dressed with 40 kg ha^{-1} N in accordance with Aydogan *et al*., (2011). Grasss pea seed at 100 kg ha^{-1} were applied to parcels in between 300 kg ha^{-1} N plus 60 kg ha^{-1} P_2O_5 in accordance with Tan and Serin, (2013). Grass pea was harvested in the period of flowering and barley plants

*Corresponding author's e-mail: seyithanseydosoglu@siirt.edu.tr

were harvested during the spike emergence period. Barley and grass pea green biomass were harvested separately on the same day with the help of hand mowers and transported to the barn in bunches. Biomass is kept in the shade for 3-4 hours and then chopped by a shredder to dimensions of 0.5-1 cm. After the shredding process, specified amount of barley and grass pea materials were mixed, homogeneous mixtures as per treatments were put in equal amounts in 3 kg plastic jars. Mixture ratios were composed of 100% barley, 100% garss pea, 75% grass pea+ 25% barley, 50% grass pea + 50% barley, 25% grass pea + 75% barley. A total of 20 plastic jars, each application with four replications, were filled. The consecutive filling technique were used in accordance with Petterson, (1988). Plastic jars were allowed to ferment in dark conditions for 45 days (Comberg, 1974). By the end of this period, the silage plastic jars were opened and 4-5 cm of the top material were removed and the remaining silage samples were observed and analyzed.

The samples taken from each jars were opened for physical evaluations by 5 people working in the laboratory and then the average of these data was calculated. The existing color, smell and structure in the silage were scored by the silage evaluation key (DLG) reported by Alcicek and Ozkan (1997). Then, using the dry matter and pH values obtained in the laboratory, Fleig scores of the feeds were determined with the help of the following formula (Kilic, 1986).

Fleig Score = 220+ (2 x% Dry Matter-15) -40 x pH

In order to measure the silage pH, samples were taken from the aqueous parts at the inner bottom of the plastic jars. 500 g of silage samples taken to represent the mass were then pre-dried for 12 hours at 70°C in the drying cabinet (Bulgurlu and Ergul, 1978). After drying, ash ratio was analyzed by Weender Analysis method, crude protein ratio by Kjeldahl method, lactic acid ratio by HPLC device, acid detergent fiber (ADF) and neutral detergent fiber (NDF) analyzes were performed according to ANKOM fiber technology method.

Data obtained in the study were evaluated statistically and variance analysis were conducted by JUMP statistical package program according to the randomised complete blok design like Kalayci, (2005).

RESULTS AND DISCUSSION

The highest total quality scores were obtained from 100% barley and 25% grass pea + 75% barley mixture where the lowest total score was obtained from 75% grass pea + 25% barley mixture. Total quality score was reduced in case of high legume mixture ratios because, it was not containing easily fermented carbohydrate type. As the barley ratio increased, silage quality was increased similar to the results of Altinok, (2002).

It is reported that taking into account the physical properties such as odor, structure and color in the determination of the silage quality will provide practical advantages (Bulutlu and Ergul, 1978). The results obtained in terms of physical properties were found similar with the studies of many researchers (Altinok, 2002; Demirel *et al*. 2010; Aykan, 2018).

Silage pH value is one of the most important factors affecting the silage fermentation and it is reported that the optimum pH range is between 3.8-4.2 for the development of acidic milk bacteria in acidic environment (Ergun *et al*., 2013).

The pH value and the dry matter ratio of the silages mixed in different proportions were found to be statistically significant based on the combined average, year, application and year x application interaction (Table 1).

Silage pH value was 3.94 in the first year and 4.05 in the second year. The highest silage pH value was obtained from 100% barley silage and the lowest silage pH value was obtained from 25% grass pea + 75% barley mixture. The highest rate of silage dry matter was obtained in the second year (30.06%) while the lowest was obtained from first year (28.63%) (Table 1). According to the two-year combined average, the highest silage dry matter ratio was obtained from 100% barley silage with 32.0%, while the lowest silage dry matter ratio was obtained from 75% grass pea + 25% barley silage mixture with 27.33%. Silage dry matter ratios increased with added barley.

Table 1: Silage pH values and dry matter ratios.

Applications	Silage pH values			Dry Matter Ratios (%)		
	1st Year	2nd Year	Average	1st Year	2nd Year	Average
%100 Grass pea	3.95d	4.03c	3.99b	27.60fg	28.48de	28.04d
%100 Barley	4.09a	4.12a	4.11a	31.00b	33.00a	32.00a
%75 Grass pea + %25 Barley	3.90e	4.06b	3.98b	26.83g	27.83ef	27.33e
%50 Grass pea + %50 Barley	3.89e	4.02c	3.96c	28.53de	29.53c	29.03c
%25 Grass pea + %75 Barley	3.86f	4.01c	3.93d	29.20cd	31.45b	30.33b
Average	3.94b	4.05a		28.63b	30.06a	
CV (%)		0.25			1.81	
LSD (year)		0.02**			0.59**	
LSD (application)		0.02**			0.56**	
LSD (year x application)		0.03**			0.78*	

* P<0.05, ** P<0.01, statistically significant.

Table 2: ADF and NDF ratios of silages.

Application	ADF Ratios of Silages (%)			NDF Ratios of Silages (%)		
	1st Year	2nd Year	Average	1st Year	2nd Year	Average
%100 Grass pea	27.21e	29.13d	28.17d	42.91e	43.90d	43.40c
%100 Barley	29.59d	30.51c	30.05b	43.73de	45.05c	44.39b
%75 Grass pea + %25 Barley	30.77c	25.90f	28.33d	44.04d	42.98e	43.51c
%50 Grass pea + %50 Barley	31.94b	26.98e	29.46c	45.92b	43.20de	44.56b
%25 Grass pea + %75 Barley	32.84a	28.98d	30.91a	47.55a	44.00d	45.78a
Average	30.47a	28.30b		44.83a	43.79b	
CV (%)		1.91			1.31	
LSD (year)		0.78**			0.56**	
LSD (application)		0.58**			0.61**	
LSD (year x application)		0.83**			0.85**	

*P <0.05, ** P <0.01, statistically significant.

An inverse relationship was found between dry matter and pH. As the amount of pea grass increased, the silage pH tended to increase. This is due to the low content of fermentable carbohydrates required for fermentation of lactic acid bacteria, high crude protein content, and inhibition of pH decreasing as a result of the conversion of proteins to ammonia during fermentation (Kilic, 1986). Similar results were obtained in different studies related to silage dry matter ratio and silage pH value (Korkmaz *et al*., 2016; Varoglu *et al*., 2016; Aykan, 2018).

The ADF ratio refers to the amount of cellulose, lignin and insoluble protein in the structure of the plant cell wall. The rate of ADF is a good indicator of feed digestibility and an insight into the animal's energy intake. The ratio of NDF refers to all the fiber in the plant including hemicellulose and fiber.

The effect of the applications on the ADF and NDF ratios of silage were found to be statistically significant according to each years and the combined averages of year, application and year x application interaction (Table 2).

Silage ADF ratios were 30.47% in the first year and 28.30% in the second year. According to the two-year combined average, the highest silage ADF ratio (30.91%) was obtained from 25% grass pea + 75% barley silage mixture whereas lowest ADF ratio (28.17%) was obtained from 100% grass pea silage. As the ratio of leguminous in the mixture increases, the ADF ratio decreases. This is explained by the high value of protein content of leguminous forage crops. ADF is a part of the fiber content in plants and as its ratio increases, feed digestibility and nutrient uptake decrease. It is therefore an important parameter of feed quality (Carr *et al*., 2004).

Silage NDF ratio was 44.83% in the first year and 43.79% in the second year. According to the two-year combined average, the highest NDF ratio (45.78%) was obtained from and 25% grass pea + 75% of the barley silage mixture, while the lowest silage NDF ratio was obtained from 100% grass pea and 75% grass pea + 25% barley silage mixture. Ross *et al*. (2004) reported that the rate of NDF increased with the increase of the cereal ratio in the mixture. In the obtained results, it is observed that the increase in barley ratio increases the rate of NDF (Table 2).

In different studies on ADF and NDF ratios, similarities and differences were observed with the obtained results (Geren 2014; Kaplan *et al*., 2014; Aykan, 2018). The differences in the obtained results probably sourced from usage of different plant materials, silage making techniques and crop harvest periods.

While the effect application and application x year interaction of silage on crude protein ratio was found to be statistically significant, year was found statistically insignificant (Table 3).

According to the combined annual average, the highest ratio of silage crude protein (22.96%) was obtained from100% grass pea silage, while the lowest crude protein ratio was obtained from 100% barley silage (Table 3). From the perspective of application x year interaction, the highest crude protein ratio was obtained from the first year of 100% grass pea silage, while the lowest crude protein ratio was obtained from the second year of 100% barley silage. As the ratio of the legume in the mixture increased, the protein ratio was increased in parallel.Similar findings were obtained in different studies on crude protein and crude ash ratio (Oliveria *et al*., 2010; Sulas *et al*., 2012; Gelir, 2018).

The effect of the silages mixed in different ratios on the lactic acid ratio and the flieg score was calculated according to the two-year and two-year combined average. Application and application x year interactions were statistically significant and the effect of years on both silage lactic acid ratio and flieg score was found to be statistically nonsignificant (Table 4).

According to the two-year combined average, the highest silage lactic acid ratio was obtained from 75% grass pea + 25% barley silage mixture, while the lowest silage acid ratio was obtained from 100% barley and 25% grass

Table 3: Silage crude protein and crude ash rates.

Application	Silage Crude Protein Ratio (%)			Silage Crude Ash Ratio (%)		
	1st Year	2nd Year	Average	1st Year	2nd Year	Average
%100 Grass pea	23.78a	22.15b	22.96a	8.40	8.60	8.50b
%100 Barley	14.93f	13.93g	14.43e	8.66	8.66	8.66ab
%75 Grass pea + %25 Barley	19.52c	19.63c	19.57b	8.28	8.47	8.37bc
%50 Grass pea + %50 Barley	17.04e	18.41d	17.72c	8.12	8.07	8.09c
%25 Grass pea + %75 Barley	16.57e	16.60e	16.58d	8.62	9.08	8.85a
Average	18.36	18.15		8.41	8.57	
CV (%)		3.51			3.32	
LSD (year)		NS			NS	
LSD (application)		0.67**			0.29*	
LSD (year x application)		0.94**			NS	

*P <0.05, ** P <0.01, statistically significant NS: Non Significant

Table 4: Silage lactic acid ratio and flieg score.

Application	Silage lactic Acid Ratio (%)			Flieg Score		
	1st Year	2nd Year	Average	1st Year	2nd Year	Average
%100 Grass pea	1.88c	1.92b	1.90b	102.10cd	100.95d	101.53c
%100 Barley	1.78e	1.88c	1.83c	103.30c	106.20b	104.75b
%75 Grass pea + %25 Barley	1.97a	1.98a	1.97a	102.75cd	98.15e	100.45c
%50 Grass pea + %50 Barley	1.89bc	1.87c	1.88b	106.55b	103.15c	104.85b
%25 Grass pea + %75 Barley	1.83d	1.81de	1.82c	109.10a	107.50ab	108.30a
Average	1.87	1.89		104.76	103.19	
CV (%)		1.12			1.24	
LSD (year)		NS			NS	
LSD (application)		0.03**			1.33**	
LSD (year x application)		0.04**			1.88**	

* P<0.05, ** P<0.01, statistically significant NS: Non Significant

pea + 75% barley silage mixture. In terms of the year x application interaction, the highest silage lactic acid ratio was obtained from the first and second years of the 75% grass pea + 25% barley silage mixture, while the lowest silage lactic acid ratio was obtained from the first year of 100% barley silage (Table 4).

Lactic acid bacteria are the most important members of microorganisms in silage during fermentation period. The amount and composition of organic acids during silage fermentation determines the quality of fermentation (Filya, 2002). It was reported by many investigators that lactic acid ratio should be higher than 2% in a quality silage (Kilic, 1986; Alcicek and Ozkan, 1997). The results obtained were close to 2%.

According to the two-year combined average, the highest flieg score was obtained from the 25% grass pea + 75% barley silage mixture, while the lowest flieg score was obtained from 75% grass pea+ 25% barley silage mixture. When the year x application interaction is considered, the highest flieg score was obtained from the first year of 25% grass pea + 75% barley silage mixture, while the lowest flieg score is obtained from 75% grass pea + 25% barley silage mixture.

When the desired pH and dry matter ratio is provided in the silo feed, the flieg score is also high. The results were also above the average score of 100 points.

CONCLUSION

As a result, it can be concluded that, a maximum of 75% legumes will be required in order to increase the crude protein content of the silages obtained by mixing the barley and grass pea. These two crops get mature close to each other during the vegetation periods. In terms of quality, the best result was obtained from % 75 grass pea + % 25 barley.

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