Legume Research, 39 (5) 2016 : 810-813
Print ISSN:0250-5371 / Online ISSN:0976-0571

AGRICULTURAL RESEARCH COMMUNICATION CENTRE
www.arccjournals.com/www.legumeresearch.in

Nutritive values of soybean silages ensiled with maize at different rates

Emine Budakli Carpici*

Uludag University, Agriculture Faculty,
Field Crops Department, Turkey.
Received: 12-03-2016 Accepted: 18-07-2016 DOI:10.18805/lr.v0iOF.3772

ABSTRACT

One of the major uses of soybean crops [*Glycine max* (L.) Merril] is as silage. However, due to its unpleasant odour and relatively high butyric acid content, soybean silage is not readily preferred by animals. Because it does not have a regular fermentation, easily fermented forage resources are needed to obtain quality silage. To improve the quality of the silage, soybeans can be mixed with an appropriate amount of maize (*Zea mays* L.). In this study, we examined the quality and properties of maize (M) and soybean (S) silages of different mixtures (100 % M, 100 % S, 10 % S + 90 % M, 20 % S + 80 % M, 30 % S + 70 % M, 40 % S + 60 % M, 50 % S + 50 % M, 60 % S + 40 % M, 70 % S + 30 % M, 80 % S + 20 % M and 90 % S + 10 % M). For this purpose, each plant species was grown separately, and the maize was harvested when the plants reached the doughy stage. The harvest was performed using a single row maize harvester that chops the plants into 1.5-2 cm pieces. The fresh plant material from each species was then mixed in different proportions and squeezed before being transferred to 1.5 L anaerobic jars (*Le Parfait, France*). The jars were opened after a 60-day ensiling period. Then, the dry matter rate, pH, silage loss, fleig point, crude protein content, ADF content and NDF content of the silages were determined. The results showed that an increase in soybean rate in the mixture decreased the dry matter rate. Conversely, the silage pH, crude protein content and ADF content increased. Our results suggested that producing quality silage required the soybean material to be mixed with a minimum of 50 % maize.

Key words: Maize, Mixture, Quality, Soybean, Silage.

INTRODUCTION

It is only possible for animals to meet their green forage needs from nature on certain days of the year, depending on the specific ecological conditions of each region. The period varies from region to region and is often limited to approximately 150 days. Thus, the animals must obtain fresh roughage from other sources (Arslan and Cakmakci 2011). In recent years, silage production has been used as a solution for this roughage deficit.

One approach to solving the roughage deficit is to plant annual forage legume-grass species together. An alternative method is to grow these species separately and then mix them in appropriate amounts. Maize is an ideal annual forage crop due to its fermentation capacity,water-soluble carbohydrate content and buffering capacity. However, the insufficient crude protein content is one disadvantage of this plant with respect to silage-making. During ensilage, urea is added and mixed with herbal materials rich in protein content (Koc *et al* 1999). Soybean silage is not readily consumed by animals because of its unpleasant odour and relatively high butyric acid level. Thus, it does not have regular fermentation and must be ensiled with other easily fermented forage plants. Soybean has a high protein content and low carbohydrate content. Therefore, soybeans have a higher buffering capacity and the proteins prevent pH decreases caused by neutralising acids. Therefore, the pH values of pure silages or silages containing a high quantity of legume do not easily decrease (Ayasan 2011). The ensilage of maize with soybean is important because it increases the crude protein content and improves other characteristics, such as energy content and taste (Kilic 1986). Koc *et al* (1999) evaluated the pH, dry matter rate and crude protein rate in 40 % M + 60% S silage and found that the values were 3.87 %, 28.12 % and 11.05 %, respectively. Demirel *et al* (2009) reported that the best results for maize-soybean silages mixed in different ratios were obtained from 20 and 30 % S + 80 and 70 % M silages.

To remove some of the negative characteristics of soybean silages, other plants such as maize can be added to the silage. But, the portions of each plant that should be mixed in must be determined. Therefore, in this study, the best mixture ratio of silage maize (*Zea mays* L.) and soybean (*Glycine max* (L.) Merril) was determined.

MATERIALS and METHODS

This study was conducted at the Experimental Area of Agricultural Application and Research Centre, Agriculture Faculty of Uludag University and in laboratory conditions at the Field Crops Department during 2015 using a factorial arrangement design with randomized complete blocks and

*Corresponding author's e-mail: ebudakli@uludag.edu.tr.

four replications. In the study, the C955 variety of maize and the Yemsoy variety of soybean were used as plant materials. The spacing between and within the rows was 0.70 m x 0.10 m for maize and 0.35 m x 0.05 m for soybean. The species were sown separately on 16 May 2015. The maize was harvested at the dough stage, and the soybean was harvested when plants reached the R5 stage. Both the maize and soybean were cut (1.5-2 cm) and then ensiled as pure plants or mixtures in 1.5 L anaerobic jars (Le Parfait, France). Each ratio had two experimental replications. Before ensilage, the dry matter rate, pH, crude protein content, ADF content and NDF content of the samples were determined for the maize and soybean materials.

We examined 11 silage mixtures (100% Maize (M), 100% Soybean (S), 90% M + 10% S, 80% M + 20% S, 70% M + 30% S, 60% M + 40% S, 50% M + 50% S, 40% M + 60% S, 30% M + 70% S, 20% M + 80% S and 10% M + 90% S). The mixtures were determined on the basis of fresh weight and were pressed into 1.5 L jars. The jars were opened after a 60-day ensilage period. A 150 g sample was then extracted from each jar, and the dry matter rates were determined by drying at 70 °C for 48 hours. A 40 g sample was mixed with 360 ml of distilled water in a stomacher bag for 4 minutes and then filtered through Whatman No. 4 filter paper (Nkosi *et al*, 2011). The pH values of the filtrates were measured with a pH metre (Sartorius PB-20, Germany). The pH values and dry matter rates were then used to determine the fleig points of the samples. The following equation was used (Geren 2001):

Fleig Point = 220+ (2 x % Dry Matter – 15) – 40 x pH

The silage weight loss was calculated according to Danley *et al* (1973). A sequential detergent analysis method was used to analyse the ADF and NDF (Goering and Van Soest 1970). The Kjeldahl method was used to the determine total nitrogen content, and the crude protein content was estimated by multiplying the total nitrogen by 6.25. The physical characteristics (colour, structure and smell) were determined according to Kilic (1986).

The dry matter rate, pH, crude protein content, ADF content and NDF content were subjected to variance analysis at the 1% and 5% significance levels using the MINITAB program. To determine the differences among the means of each parameter affected by the treatments, the LSD test was conducted at a 5% significance level using the MSTAT-C program.

RESULTS and DISCUSSION

The dry matter rate, pH, crude protein content, ADF content and NDF content of the maize and soybean forage at harvest are presented in Table 1. The maize values were as follows: dry matter rate 31.41%, pH 5.89, crude protein content 6.50 %, ADF content 23.65%, and NDF content 43.16%. The soybean plant values were as follows: dry matter rate 21.83%, pH 6.31, crude protein content 19.19 %, ADF content 29.10% and NDF content 41.39% (Table 1).

Table 1: Dry matter rate, pH, crude protein, ADF and NDF contents of maize and soybean forage.

	Dry matter ratio (%)	pH	Crude protein (%)	ADF (%)	NDF (%)
Maize	31.41	5.89	6.50	23.65	43.16
Soybean	21.83	6.31	19.19	29.10	41.39

Table 2: Dry matter rate, pH and weight loss of maize-soybean mixtures silages at different rate.

Mixtures	Dry matter rate (%)	pH	Weight Loss (%)
100 % M	31.49a	4.00d	0.43cd
100 % S	19.66d	5.38a	1.26a
10 % S + 90 % M	32.25a	4.00d	0.41d
20 % S + 80 % M	31.45a	4.11c	0.47 b-d
30 % S + 70 % M	28.88b	4.15c	0.53bc
40 % S + 60 % M	29.15b	4.13c	0.48 b-d
50 % S + 50 % M	26.50c	4.17c	0.46cd
60 % S + 40 % M	24.39c	4.31b	0.53bc
70 % S + 30 % M	24.55c	4.37b	0.58 b
80 % S + 20 % M	21.90d	5.32a	1.16a
90 % S + 10 % M	19.96d	5.34a	1.25a
F value			
Mixtures	**	**	**

Means of the same column followed by the same letter were not significantly different at the 0.05 level using LSD test.
*, **: F-test significant at p ≤/0.05, and p ≤/0.01, respectively. ns: not significant

The dry matter rate, pH and silage weight loss of the maize-soybean mixtures are shown in Table 2. The crude protein, ADF and NDF contents of the silage mixtures are shown in Table 3. The physical characteristics (colour, smell and structure) of the mixed silages are presented in Table 4. There were significant differences ($P < 0.01$) in the dry matter rate were observed among the silage types. The highest dry matter rate was 32.25% in 90% M + 10% S mixture, and the lowest dry matter rates were determined in the 100% S (19.66%) and 90% S + 10% M (19.96%) mixtures. The dry matter rates of the silages decreased as the rates of maize in the mixture decreased (Table 2). There was significant variation in pH among the silage types ($P < 0.01$).

It was found that as the amount of soybean added to the silage increased, the pH values increased. Thus, the highest pH values were identified in mixtures of 100% S, 80% S+ 20% M and 90% S + 10% M (Table 2). This result

Table 3: Crude protein, ADF and NDF contents of maize-soybean mixtures silages at different rate.

Mixtures	Crude Protein (%)	ADF (%)	NDF (%)
100 % M	7.08i	22.86e	41.82
100 % S	17.43a	37.75 a	44.13
10 % S + 90 % M	8.86h	20.48 f	44.56
20 % S + 80 % M	9.73g	24.98 d	43.27
30 % S + 70 % M	11.65f	24.99d	42.45
40 % S + 60 % M	12.46e	25.31d	45.53
50 % S + 50 % M	13.32d	26.35d	44.13
60 % S + 40 % M	14.82c	29.20c	43.70
70 % S + 30 % M	15.60b	28.98c	42.11
80 % S + 20 % M	15.74b	34.69b	43.28
90 % S + 10 % M	15.60b	38.27a	43.32
F Value			
Mixtures	**	**	ns

Means of the same column followed by the same letter were not significantly different at the 0.05 level using LSD test.
*, **: F-test significant at p ≤/0.05, and p ≤/0.01, respectively. ns: not significant

is due to the low content of fermentable carbohydrate, which is required for lactic acid bacteria function. The result is also attributable to proteins preventing the silage pH from decreasing through protein destruction of ammonia (Kilic 1986).

Demirel *et al* (2009) stated that the lowest pH content was obtained from 80% M + 20% S mixture. Zago *et al* (1985) reported that in maize-soybean silages, the pH value was not affected by increases in soybean content. However, Saruhan *et al* (2011) reported that the pH value increased as the rate of legume increased in legume-poaceae silages. Significant differences in weight loss (P < 0.01) were found among the silage types. The loss in the maize-soybean silages varied between 0.41-1.26%. The highest loss of silage occurred in the 100% S (1.26%), 90% S+ 10% M (1.25%) and 80 S % + 20 M% (1.16%) mixtures (Table 2).It was emphasized by many researchers that even the highest weight loss values obtained in our study could be ignored (Kavut *et al* 2012; Iptas *et al* 2009; Kilic, 1986). These researchers stated that even in the ideal ensilage environment, losses as high as 3-5% could occur due to respiration or fermentation.

Significant differences (P < 0.01) were found among silage types with respect to crude protein content. The highest crude protein content was obtained from 100% S (17.43%), while the lowest crude protein content was found in 100% M. In general, as the soybean rates increased to 70%, the crude protein content also increased. The crude protein content of the mixtures containing 70%, 80% and 90% soybean were similar (Table 3). Demirel *et al* (2009) and Martínez-García *et al* (2015) reported that as the soybean rate in the mixture increased, the rate of crude protein in the silage also increased. Arslan and Cakmakci (2011) stated that the crude protein content of 90% M +10% S mixture was 8.34%. Our results are in harmony with these findings.

There were significant differences (P < 0.01) in the ADF contents of the mixture silages. The highest ADF contents were obtained from 100% S (37.75%) and 90% S + 10% M (38.27%). The lowest ADF content of 22.86% was obtained from 100% M (Table 3). Similar results were also reported by Demirel *et al* (2009).

The differences in the NDF contents of the silages were not statistically significant, ranging from 40.18-47.04% (Table 3). Similar results were also reported by Demirel *et al* (2009).

The silages of maize-soybean mixtures have important variations with respect to physical characteristics associated with quality (Table 4). The highest quality silages were produced from the following ratios: 100 % M, 10% S + 90% M, 20% S + 80% M, 30% S + 70% M, 40% S + 60% M and 50% S +50% M silage (supreme quality). The poorest quality silage was obtained from 100 % S, 90% S+ 10% M and 20% S + 80% M. Karakozak and Ayasan (2010) reported that a 30% S +70% M mixture had good quality and that the silages of 50% S + 50% M and 70% S + 30% M mixtures were of medium quality.

Table 4: Physical characteristics (color, smell and structure) of maize-soybean mixture silage

Silage type	Color	Smell	Structure	Total	Quality
100 % M	2	14	4	20	Supreme
100 % S	0	2	1	3	Very bad
10 % S + 90 % M	2	14	4	20	Supreme
20 % S + 80 % M	2	14	4	20	Supreme
30 % S + 70 % M	2	10	4	16	Supreme
40 % S + 60 % M	2	10	4	16	Supreme
50 % S + 50 % M	2	10	4	16	Supreme
60 % S + 40 % M	1	4	2	7	Medium
70 % S + 30 % M	1	2	2	5	Medium
80 % S + 20 % M	0	2	1	3	Very bad
90 % S + 10 % M	0	2	1	3	Very bad

CONCLUSIONS

In conclusion, after the soybean rate in the mixture increased to 50%, no significant change in silage quality took place relative to the quality of 100% maize silage. When the soybean content in the mixture exceeded 50%, the silage pH began to increase gradually. The protein content in the 50% S + 50 % M mixture was higher than that of silages with soybean rates less than 50%; however, the ADF content of this mixture was lower. Based on the silage properties determined in this study, silage composed of 50% S + 50% M is recommended to animal producers due to its higher quality.

ACKNOWLEDGMENT

This research was supported by the Scientific Research Projects Unit of Uludag University (Project No: HDP(Z-2015/41, Project Leader: Dr. Emine Budakli Carpici). The author is grateful to the Scientific Research Projects Unit of Uludag University for financial support. The author wish to thanks American Journal Experts (AJE) for editing and English proofreading of the manuscript. The author also thank Uludag University for editing and English proofreading service support.

REFERENCES

Arslan, M. and Cakmakci, S. (2011). Comparison of corn (*Zea mays*) and sorghum (*Sorghum bicolor*) silages mixed with different plants. *Akdeniz University Journal of the Faculty of Agriculture*, **24:** 47-53.

Ayasan, T. (2011). Soybean silage and usage of animal nutrition. *Journal of Faculty of Veterinary Medicine Erciyes University*, **8:**193-200.

Danley, M.M., Vetter, R.L. and Wedin, W.F. (1973). Modified laboratory silo unit for studying the fermentation of maize (*Zea mays* L.) grain. *Agronomy Journal*, **65:** 621-624.

Demirel, M., Celik, S., Temur, C., Güney, M. and Celik, S. (2009). Determination of fermentation properties and digestibility characteristics of combination of corn-soybean and corn silages. *Journal of Animal and Veterinary Advances*, **8:**711-714.

Geren, H. (2001). Effect of sowing dates on silage characteristics of different maize cultivars grown as second crop under Bornova conditions. *The Journal of Ege University Faculty of Agriculture*, **38:** 47-54.

Goering, M.K. and Van Soest, P.J. (1970). Forage Fibre Analysis. USDA Agricultural Handbook, USA, **379:**1-20.

Iptas, S., Geren, H. and Yavuz, M. (2009). Forages, 'General Section', Section 4.2 Silage Technique. *Republic of Turkey Ministry of Food, Agriculture and Livestock*, **1:**142-162.

Karakozak, E. and Ayasan, T. (2010). Effect of inoculant in silages in which different forage crops and their mixtures on flieg point and crude nutrient content. *Journal of the Veterinary Medicine, Kafkas Univesity*, **6:** 987-994.

Kavut, Y.T., Soya, H., Geren, H., Geren, H., Ünsal, R., Sevim, I. and Avcioglu, R. (2012). investigations on the herbage yield for silage and silage quality characteristics of some triticale cultivars grown under Menemen conditions. *Journal of the Aegean Agricultural Research Institute*, **22:** 33 – 44.

Kilic A. (1986). Silage (Suggestion for Education, Instruction and Application) Bilgehan Basimevi, Izmir, 350 p.

Koc, F., Özdüven, M.L., Yurtman, I.Y. (1999). Effects of salt and microbial 1noculants on the quality and aerobic stability of the maize-soybean silage. *Journal of Animal Production*, **39–40:** 64–71.

Martínez-García, C.G., Valencia-Núñez, K., Bastida-López, J., Estrada-Flores, J.G., Lama, G.C.M., Cruz-Monterrosa, R.G., Rayas-Amor, A.A. (2015). Effect of different combinations of soybean-maize silage on its chemical composition, nutrient intake, degradability, and performance of Pelibuey lambs. *Trop Anim Health Prod*. 47(8), DOI: 10.1007/s11250-015-0898-0

Nkosi, B.D., Kanengoni, A.T. and Thomas, R. (2011). Effects of ensiling total mixed potato hash ration with or without bacterial inoculation on silage fermentation and nutritive value for growing pigs. *Journal of Animal and Veterinary Advances*, **10:**1667-1672.

Saruhan, V., Demirel, R., Baran, S. and Demirel, D.S. (2011). Determination of ensilage properties of different levels of lotus corniculatus and hordeum vulgare mixtures. *Anadolu Journal of Agriculture Science*, **26:**40-45

Zago, C.P., Obeid, J.A. and Gomide, J.A. (1985). Performance of steers fed with joined ensilages of maize (*Zea mays* L.) with annual soyabean (*Glycine max* L.). *Brazilian Journal of Animal Science, Vicosa*, **14:** 510-514.,