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Determination of Fermentation Properties and Digestibility Characteristics of Combination of Corn-Soybean and Corn Silages

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Abstract: This study was conducted to determine *in vivo* digestibility and fermentation property of various silages made of green herbage of Corn (C) and corn-soybean mixtures at different rates (90% corn + 10% soybean (90C10SB), 80% corn + 20% soybean (80C20SB), 70% corn + 30 soybean (70C30SB)). Each mixture was prepared at rates given above on fresh material basis and ensiled in 120 L plastic barrels (a total of 20, 5 replicate for 4 treatments) for 90 days. pH values of C silage were higher and acetic acid levels were lower than that of 80C20SB ($p<0.05$). Concentrations of lactic and propionic acid of corn-soybean mixture silages were found to be similar to C silage. Digestibility of DM, OM, ADF and NDF were higher in C silage than that of other silages, whereas digestibility of CP and EE of 80C20SB silage were higher than corn silage ($p<0.05$). It was concluded that ensiling corn with 20 or 30% soybean addition at green herbage basis generates desirable outcomes for fermentation properties and digestibility of crude nutrients.

Key words: Corn and corn-soybean mixture silage, fermentation, digestibility, determination, properties

INTRODUCTION

Since, there is drought problem in semi-dry climates alternative feed production and conservation techniques have great importance. Corn has ideal properties from stand point of determinative view for ensiling efficiency because, it has high Dry Matter (DM) content, low buffer capacity and appropriate water soluble carbohydrate level for lactic acid fermentation. Insufficient CP is main disadvantage of corn. Urea addition during ensiling and ensiling it with high protein containing feed are main practices to eliminate this disadvantage (Mc Donald *et al*., 1991).

Soya silage is not consumed easily by animals because of its undesirable smell and free ammonia and butyric acid levels. In order to provide regular fermentation addition of easily fermentable carbohydrate is suggested. For this aim, ensiling corn or sorghum is suggested to be ensiled as 50-50% (Brown, 1999). It was reported that ensiling corn with soya bean not only increased CP content but also energy content and taste of soya bean (Blaunt *et al*., 2006).

This study was done to determine the effects of ensiling soybean with corn mixed at different ratio on silage fermentation properties and nutrient matters digestibility.

MATERIALS AND METHODS

Corn and soybean harvested with a silo track at early dough stage of maturity were used as silage material. Green herbage of Corn (C) and corn-soybean mixtures at different rates (90% corn + 10% soybean (90C10SB), 80% corn + 20% soybean (80C20SB), 70% corn + 30 soybean (70C30SB)) were prepared on fresh material basis, tightly filled in plastic 120 L barrels (a total of 20, 5 replicate for 4 treatments), closed with lid and sealed. Then, barrels were turned upside down and placed for fermentation. Barrels were opened 90 days later and sampled for chemical analysis. The chemical composition of fresh material is given in Table 1.

The pH of the silages was determined in samples immediately after they were obtained. Samples were taken from upper, central and bottom of each silage barrel (Hart and Horn, 1987). Then the remaining silage fluid was filtered through Whatman 54 paper, centrifuged and stored at -20°C. Lactic, acetic, propionic and butyric acids in silage fluids were analyzed using high performance liquid chromatography (Muck and Dickerson, 1988).

The digestibility of silages was determined with conventional *in vivo* digestibility technique using 5, 2 year old Akkaraman ram lambs (average 30-35 kg body weight). Metabolism trail (feeding of animals, determination

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Table 1: Crude nutrient matter contents of corn, soybean and corn-soybean green herbages to prior ensiling (DM%)

Contents	C	SB	90C10SB	280C0SB	70C30SB
DM	26.55	32.23	29.03	27.68	29.96
OM	85.72	85.56	83.96	85.12	84.31
CP[1]	1.81	4.94	2.18	2.21	2.29
EE	2.11	7.69	2.98	3.18	3.69
ADF	35.21	37.49	37.21	37.95	37.47
NDF	48.38	49.51	49.63	48.62	48.07

[1]Fresh material

of feed intake, collection of feces and analysis) was conducted as described by Bulgurlu and Ergul (1978).

The Dry Matter (DM), Crude Protein (CP), Ether Extracts (EE) and ash analyses of silages and faces were done according to AOAC (1990). Crude protein analysis was done in wet samples. Acid Detergent Fiber (ADF) and Neutral Detergent Fiber (NDF) were analyzed according to Van Soest *et al.* (1991). PROC GLM in SAS/STAT (2007) was used for all data analysis. Mean treatment differences were determined by Duncan's multiple range tests with a level of statistical differences of 5%.

RESULTS AND DISCUSSION

Considering the findings for nutrient contents of corn and corn-soybean mix silages it was noted that as the ratio of soybean in the mix increased the relative amounts of DM, OM, CP and EE increased (Table 2). Carneiro *et al.* (1982) reported that silage DM increased as the ratio of soybean in the mix increased in corn and corn-soybean mixture silages mixed at 20 and 40%. Evangelista (1986) found that nutrient value and quality of corn-soybean mix silages improved related to the increase of soybean in the mix. This researcher also, pointed out that 6.5% CP dry^{-1} matter of corn and sorghum silage increased to 8.5-9.0% when soybean ratio was 30% in the mix.

pHs of C, 90C10SB and 70C30SB silages were similar but were >80 C20SB ($p<0.05$). Acetic acid concentration of C silage was lower compared to 80C20SB silage ($p<0.05$), however, similar to other silages. Acetic acid concentration of 80C20SB silage was higher than 70C30SB silage ($p<0.05$). No differences were noted for butyric acid concentrations among silage groups. No differences were noted for propionic and lactic acid concentrations between C silage and corn-soybean mix silage.

However, lactic acid concentration of 80C20SB silage was higher than 80C20SB; propionic acid concentration of 90C10SB silage was higher than 70C30SB silage ($p<0.05$, Table 3). Although, it was reported that as the ratio of feed having high protein ratio and low easily fermentable carbohydrate increased the pH of silage increased (Cerci *et al.*, 1997; Demirel *et al.*, 2001a, b) but this was not observed in the present study. In the mean time, although

Table 2: Crude nutrient matter contents of corn and corn-soybean mixture silages (%)

Contents	CC	90C10SB	80C20SB	70C30SB
DM	26.02	28.88	27.16	28.87
OM	82.55	83.65	84.83	83.71
CP[1]	1.72	2.02	2.14	2.17
EE	2.01	2.98	3.02	3.65
ADF	34.52	36.57	37.90	36.47
NDF	47.80	48.22	47.52	47.57

[1]Fresh material

Table 3: Crude nutrient matter digestibility to fermentation properties of corn and corn-soybean mixture silage at different ratios

	C	90C10SB	80C20SB	70C30SB
Concentrations	$\bar{X} \pm s\bar{x}$	$\bar{X} \pm s\bar{x}$	$\bar{X} \pm s\bar{x}$	$\bar{X} \pm s\bar{x}$
Fermentation properties				
pH	4.42±0.06a	4.36±0.06a	3.95±0.08b	4.32±0.08a
Acetic acid	2.28±0.46b	3.74±0.46ab	5.19±0.57a	2.34±0.57b
Butyric acid	0.25±0.110	0.60±0.110	0.34±0.140	0.26±0.140
Propionic acid	0.85±0.17ab	1.41±0.17a	1.07±0.21ab	0.67±0.21b
Lactic acid	8.69±0.78ab	6.39±0.78b	9.89±0.96a	8.74±0.96ab
Digestibility				
DM	66.23±0.80a	63.14±0.80b	63.05±0.80b	62.17±0.80b
OM	69.10±0.73a	64.52±0.73b	64.93±0.73b	63.40±0.73b
CP	51.54±1.70b	55.56±1.70b	62.27±1.70a	61.56±1.70a
EE	89.21±0.85b	91.71±0.85ab	93.00±0.85a	91.46±0.85ab
ADF	64.93±0.93a	59.02±0.93b	57.14±0.93b	57.06±0.93b
NDF	65.82±1.20a	58.98±1.20bc	57.14±1.20b	56.31±1.20c

there were increases in CP concentrations in mix silages having 30-50% soybean, for optimum pH and lactic acid concentrations there was no need for easily fermentable carbohydrate additives (Martin *et al.*, 1983). When pH, acetic, propionic, butyric and lactic acid quality criteria are considered, it appeared that applied mix ratios did not generate any adverse effect on fermentation potential. pH values obtained in the present study were found within the range required optimum silage fermentation (Alcicek and Ozkan, 1997). It was reported that pH and lactic acid levels in corn and 35, 40 and 50% (Evangelista *et al.*, 2005), or 20, 30 and 40% soybean containing silages. Zago *et al.* (1985) were similar to corn silages and fermentation properties did not change with the increase in soybean ratio.

ADF and NDF digestibility of corn-soybean mix silages was lower than that of C silage ($p<0.05$). The increase in soybean ratio in the mixture did not affect the decrease in ADF digestibility, whereas the decrease in NDF digestibility was significant ($p<0.05$; Table 3). Anil *et al.* (2000) reported lower DM, OM, ADF and NDF digestibilities for corn-sunflower mix silage than that of corn silage. They reported higher CP digestibility for corn-sunflower mix silage. In other studies, it was reported that as ADF and NDF increased in corn-sunflower mix silages DM digestibility decreased; as the CP content increased CP digestibility increased (Nocek and Russell, 1988; Immig and Pabst, 2000). Murphy *et al.* (1984) found no differences in DM, CP and ADF digestibility between corn

and corn-soybean mix silages. Addition of 40% soybean did not affect DM digestibility (Martin *et al*., 1983). Carneiro *et al*. (1982) found that CP digestibility of corn silage containing soybean at 20 and 40% ratio was higher than that of corn silage and noted that CP digestibility increased as soybean ratio increased in the mix.

CONCLUSION

Ensiling corn with soybean, an alternative feed crop, at different mix ratio to improve its crude protein content did not generate any adverse result and produced high quality silages. Although, digestibility of soybean is low because of its cell wall components, the proportional increase of soybean in the mixture improved digestibility of some other nutrients. Ensiling corn with addition of soybean at the rate of 20 or 30%, as green herbage basis, generated 2 benefits; increased corn protein content and improved fermentation properties of soybean.

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