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Effect of Ensiling of Alfalfa with Sorghum on the Chemical Composition and Nutritive Value of Silage Mixtures

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Abstract: The aim of this study was to determine the effect of ensiling of alfalfa plant with sorghum plant on the chemical composition and nutritive value of silage mixtures using *in vitro* gas production technique. Chemical composition including; Dry Matter (DM), Crude Protein (CP), Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF), Ash Volatile Fatty Acids (VFA), lactic acid and pH were determind. Gas productions were determined at 0, 3, 6, 12, 24, 48, 72 and 96 h incubation times and their kinetics were estimated using the exponential equation $Y = A (1 - \exp^{-ct})$. The Organic Matter Digestibility (OMD) and Metabolisable Energy (ME) of the resultant silages were estimated. Ensiling of alfalfa plant with sorghum plant had a significant effect on the chemical composition, fermentation parameters, potential gas production, OMD and ME values of the resultant silages. Ensiling of alfalfa with sorghum plant increased the lactate and propionate production, OMD, ME but decreased acetate and butyrate production, CP content and pH of the resultant silage. As a conclusion, ensiling of alfalfa plant with sorghum plant will overcome some of the drawbacks related to low DM and water soluble carbohydrate contents and high buffering capacity of alfalfa plant.

Key words: Alfalfa silage, sorghum silage, potential nutritive value, *in vitro* gas production, OMD, Turkey

INTRODUCTION

Alfalfa is one of leguminous plants which is very difficult to ensile due to their low Dry Matter (DM), water soluble carbohydrate content and high buffering capacity and difficulty of wilting (Singh *et al*., 1996; Davies *et al*., 1998; McAllister *et al*., 1998). However, Ozturk indicated that ensiling of alfalfa with whole crop maize had a significant effect on the chemical composition, pH, *in vitro* DM degradability, *in vitro* OMD and ME of the resultant silage mixtures. Ensiling of alfalfa with whole crop maize plant overcome some of the drawbacks related to low DM and water soluble carbohydrate contents and high buffering capacity of alfalfa plant. Recently in addition to chemical composition, the gas production technique have been widely used to evaluate the potential nutritive value of uninvestigated ruminant feedstuffs (Mesgaran and Mohammadabadi, 2010; Mesgaran *et al*., 2010; Chaji *et al*., 2010; Kamalak, 2010). Therefore, the aim of this study was to determine the effect of ensiling of alfalfa with sorghum on the chemical composition and nutritive value of silage mixtures using *in vitro* gas production technique.

MATERIALS AND METHODS

Silage samples: Alfalfa plant was harvested at the beginning of flowering (~10%) for silage production.

Table 1: Silages combinations

Silages	Alfalfa	Sweet sorghum
A	100	0
B	75	25
C	25	75

Whole sweet sorghum crop was harvested at the stage of milk line. Representative alfalfa and sweet sorghum plants were chopped to about 2-3 cm in length. Chopped plant materials were ensiled in plastic experimental silo with a capacity of 5 kg. The silage combinations used in this experiment are given in Table 1.

Chemical analysis: The plastic experimental silos containing the silages were opened after 2 months. The resultant silages were dried and grounded to pass through 1 mm sieves for subsequent analysis. Dry matter content was determined by drying the samples at 105°C overnight and the ash content was determined by igniting the samples in a muffle furnace at 525°C for 8 h. Nitrogen (N) content was measured by the Kjeldahl method (AOAC, 1990). The CP was calculated as N×6.25. The Neutral Detergent Fiber (NDF) and Acid Detergent Fiber (ADF) of pepper leave sample were analyzed with the ANKOM fiber analyzer using reagents described by Van Soest (1963) and Van Soest and Robertson (1985), respectively. The organic acids of the resultant silages were determined by gas chromatograph. The pH of the resultant silage was determined using the pH meter. All chemical analyses were carried out in triplicate.

***In vitro* gas production:** The silage samples milled through a 1 mm sieve were incubated *in vitro* rumen fluid in glass bottles following the procedures of Theodorou *et al.* (1994). Rumen fluid was obtained from three fistulated sheep fed twice daily with a diet containing alfalfa hay (60%) and concentrate (40%). Approximately 0.200 g dry weight of silage sample was incubated in a glass bottle of 100 mL containing 50 mL of McDougall's buffer/rumen mixture in triplicate. Gas production was determined at 3, 6, 12, 24, 48, 72 and 96 h after incubation using pressure transducer. Total gas production was corrected for blank gas production. The *in vitro* gas production kinetics was estimated using the exponential model:

$$y = A (1 - \exp^{-ct})$$

Where:
y = Gas produced at time (t)
A = The potential gas production
c = The gas production rate (%)
t = Incubation time (h)

ME (MJ/kg DM) contents of silage sample were estimated using equation suggested by Menke *et al.* (1979) as follows:

$$ME (MJ/kg DM) = 2.20+0.136 GP+0.057 CP$$

Where:
GP = 24 h net gas production (mL/200 mg)
CP = Crude protein

Organic matter digestibility (%) of silage samples was estimated using equation suggested by Menke *et al.* (1979) as follows:

$$OMD (\%) = 14.88+0.889 GP+0.45 CP+0.0651 XA$$

where, XA is ash content (%).

Statistical analysis: One-way analysis of variance was carried out to determine the effect of ensiling of alfalfa with sorghum on the chemical composition and nutritive value of silage mixtures using the General linear model. Significant differences between individual means at $p<0.05$ were identified using the Duncan multiple range tests. Standard errors of means were calculated from the residual mean square in the analysis of variance.

RESULTS AND DISCUSSION

The effect of ensiling of alfalfa plant with sorghum plant on the chemical composition of the resultant silages is shown in Table 2. Ensiling of alfalfa plant with sorghum plant had a significant effect on the chemical composition of the resultant silages. The CP content of the resultant silages decreased with increasing level of sorghum plant in silage mixture, since the CP content of sorghum plant was lower than that of alfalfa plant. This result is in agreement with finding of Ozturk who showed that ensiling alfalfa plant with maize plant decreased the CP contents of the resultant silage with increasing level of maize plant in the silage mixture.

Table 2: The effect of ensiling of alfalfa plant with sorghum plant on the chemical composition of the resultant silages

	Silages				
Compositions	A	B	C	SEM	Sig.
DM	24.71	24.29	23.70	0.672	NS
Ash	8.70	9.06	9.06	0.180	NS
CP	18.93^{a}	14.58^{b}	11.40^{c}	0.408	***
NDF	47.39^{b}	46.24^{b}	56.18^{a}	0.959	***
ADF	41.08^{a}	39.27^{ab}	35.73^{c}	1.362	*

$^{a-c}$Row means with common superscripts do not differ ($p>0.05$); SEM: Standard Error Mean; Sig.: Significance level; DM: Dry Matter; CP: Crude Protein; NDF: Neutral Detergent Fiber; ADF: Acid Detergent Fiber

Table 3: The effect of ensiling of alfalfa plant with sorghum plant on the pH, volatile fatty acids and lactate contents of the resultant silages

	Silages				
Compositions	A	B	C	SEM	Sig.
pH	5.51^{a}	4.53^{b}	4.17^{c}	0.049	***
Acetate	50.06^{a}	47.02^{a}	37.90^{b}	1.400	***
Propionate	7.79^{c}	11.27^{b}	15.48^{a}	0.206	***
Butyrate	42.63^{a}	16.33^{b}	12.95^{c}	0.558	***
Lactate	2.03^{c}	14.18^{b}	31.60^{a}	1.138	***

$^{a-c}$Row means with common superscripts do not differ ($p>0.05$); SEM: Standard Error Mean; Sig.: Significance level

The effect of ensiling of alfalfa plant with sorghum plant on the pH, volatile fatty acids and lactate contents of the resultant silages is shown in Table 3. Ensiling of alfalfa plant with sorghum plant had a significant effect on the pH, volatile fatty acids and lactate contents of the resultant silages. The silage pH of resultant silages decreased with increasing level of sorghum plant in silage mixtures, since maize plant in the mixture provide water soluble carbohydrate for lactic acid bacteria to produce the lactic acid which is mainly responsible for decrease the silage pH. This result is in agreement with finding of Ozturk who showed that ensiling alfalfa plant with maize plant decreased pH of the resultant silage with increasing level of maize plant in the silage mixture. As can be seen from Table 3, the ensiling of alfalfa with sorghum plant increased the lactate and propionate production but decreased the acetate and butyrate production of the resultant silage.

The effect of ensiling of alfalfa plant with sorghum plant on the *in vitro* gas production of the resultant silages is shown in Fig. 1. Ensiling of alfalfa plant with

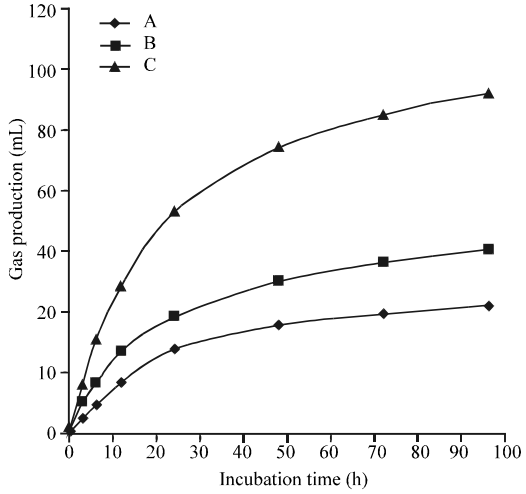

Fig. 1: The effect of ensiling of alfalfa plant with sorghum plant on the *in vitro* gas production of the resultant silages

Table 4: The effect of ensiling of alfalfa plant with sorghum plant on the *in vitro* gas production kinetics, metabolisable energy and organic matter digestibility of the resultant silages

	Silages				
Compositions	A	B	C	SEM	Sig.
c	0.0426	0.0487	0.0472	0.108	NS
A	36.1100^{c}	50.1100^{b}	93.5700^{a}	5.468	***
OMD	44.6400^{c}	50.8300^{b}	75.6300^{a}	3.531	***
ME	6.5200^{a}	7.5100^{b}	11.3400^{a}	0.536	***

$^{a-c}$Row means with common superscripts do not differ ($p>0.05$); SEM: Standard Error Mean; Sig.: Significance level; A = Potential gas production; c = The gas production rate; ME: Metabolisable Energy, MJ/kg DM; OMD: Organic Matter Digestibility (%); ***$p<0.001$

sorghum plant had a significant effect on the *in vitro* gas production of the resultant silages. At all incubation times gas production from silage C was significantly higher than those of silage A and B. The fermentation kinetics, metabolisable energy and organic matter digestibility of the silages is shown in Table 4. Ensiling of alfalfa plant with sorghum plant had a significant effect on the fermentation kinetics, metabolisable energy and organic matter digestibility of the resultant silages. The silage C had a significantly higher potential gas production, OMD and ME values than those of silage A and B. This result is in agreement with finding of Ozturk who showed that ensiling alfalfa plant with maize plant increased the potential gas production, OMD and ME of the resultant silage with increasing level of maize plant in the silage mixture.

The reason why the potential gas production, ME and OMD values of the resultant silages (B and C) containing sorghum were higher than that silage A is possible due to high water soluble carbohydrate content of sorghum which is available for rumen micro-organism. The increase in inclusion rate of sorghum increased the fermentable carbohydrate in silage mixture. The increased fermentable carbohydrate results in high volatile fatty acid production by rumen micro-organisms. It well known that the gas production is associated with volatile fatty acid production as a result of fermentation of carbohydrate in feedstuffs (Blummel and Orskov, 1993). The more fermentable carbohydrate will be available for the micro-organisms the more gas production occurs. As a result of these, ME and OMD estimated from the chemical composition and gas production at 24 h incubation time will be higher than that of silage A which is not containing sorghum.

CONCLUSION

Ensiling of alfalfa with sorghum had a significant effect on the chemical composition, pH, *in vitro* gas production OMD and ME of the resultant silage mixtures. It appears that ensiling of alfalfa with sorghum plant will overcome some of the drawbacks related to low DM and water soluble carbohydrate contents and high buffering capacity of alfalfa plant.

REFERENCES

AOAC, 1990. Official Methods of Analysis. Association of Official Analytical Chemists, Washington, DC. USA., pp: 69-88.

Blummel, M. and E.R. Orskov, 1993. Comparison of *in vitro* gas production and nylon bag degradability of roughages in predicting feed intake in cattle. Anim. Feed Sci. Technol., 40: 109-119.

Chaji, M., T. Mohammadabadi, M. Mamouei and S. Tabatabaei, 2010. The effect of processing with high steam and sodium hydroxide on nutritive value of sugarcane pith by *in vitro* gas production. J. Anim. Vet. Adv., 9: 1015-1018.

Davies, D.R., R.J. Merry, A.P. Williams, E.L. Bakewell, D.K. Leemans and J.K.S. Tweed, 1998. Proteolysis during ensilage of forages varying in soluble sugar content. J. Dairy Sci., 81: 444-453.

Kamalak, A., 2010. Determination of potential nutritive value of *Polygonum aviculare* hay harvested at three maturity stages. J. Applied Anim. Res., 38: 69-71.

McAllister, T., R. Feniuk, Z. Mir, P. Mir, L. Selinger and K. Cheng, 1998. Inoculants for alfalfa silage: Effects on aerobic stability, digestibility and the growth performance of feedlot steers. Livest. Prod. Sci., 53: 171-181.

Menke, K.H., L. Raab, A. Salewski, H. Steingass, D. Fritz and W. Schneider, 1979. The estimation of digestibility and metabolizable energy content of ruminant feedstuffs from the gas production when they incubated with rumen liquor *in vitro*. J. Agric. Sci. Camb., 92: 217-222.

Mesgaran, M.D. and T. Mohammadabadi, 2010. The effect of fat content of chemically treated sunflower meal on *in vitro* gas production parameters using isolated Rumen microbiota. J. Anim. Vet. Adv., 9: 2466-2471.

Mesgaran, M.D., M. Malakkhahi, A.R.H. Moussavi, A. Vakili and A. Tahmasbi, 2010. *In situ* ruminal degradation and *in vitro* gas production of chemically treated sesame stover. J. Anim. Vet. Adv., 9: 2256-2260.

Singh, K., H. Honig, M. Wermke and E. Zimmer, 1996. Fermentation pattern and changes in cell wall constituents of straw-forage silages, straws and partners during storage. Anim. Feed Sci. Technol., 61: 137-153.

Theodorou, M.K., B.A. Williams, M.S. Dhanoa, A.B. McAllan and J. France, 1994. A simple gas production method using a pressure transducer to determine the fermentation kinetics of ruminant feeds. J. Anim. Feed Sci. Technol., 48: 185-197.

Van Soest, P.J. and J.B. Robertson, 1985. A Laboratory Manual for Animal Science. Cornell University Press, Ithaca, New York, pp: 612.

Van Soest, P.J., 1963. Use of detergents in the analysis of fibrous feeds. II. A rapid method for the determination of fibre and lignin. J. Assoc. Official Agric. Chemists J., 46: 829-835.