Journal of Animal and Veterinary Advances 8 (10): 1921-1924, 2009
ISSN: 1680-5593
© Medwell Journals, 2009

The Effects of Adding Urea and Molasses to Corn Harvested at Dough Stage on Silage Fermentation Quality, *in vitro* Organic Matter Digestibility and Metabolic Energy Contents

[1]Sibel Çelik, [1]Cemal Budag, [1]Murat Demirel, [2]Yunus Bakici and [3]Savas Çelik
[1]Department of Animal Science, Faculty of Agricultural, Yuzuncu Yil University, Van, Turkey
[2]Ministry of Agricultural and Rural Affairs, Bitlis Country Management, Bitlis, Turkey
[3]Ministry of Agricultural and Rural Affairs, Gevas District Management, Van, Turkey

Abstract: The aim of this study was to evaluate the effects of ensiling corn harvested at the milk stage by addition of various amount of Molasses (M), Urea (U) and Urea + Molasses (U×M) on quality, *in vitro* Organic Matter Digestibility (IVOMD) and Metabolic Energy (ME) contents. Five silage samples from 16 treatment groups were prepared in 1 l jars and incubated for 70 days. The ME values and IVOMD with lactic acid levels of 1% U added silages were higher compared to other silages. It has been concluded that either unsupplemented or 1% U added ensiling will be a suitable ensiling technique to corn.

Key words: Corn, silage quality, *in vitro* organic matter digestibility, metabolic energy, urea, fermentation

INTRODUCTION

In silo fodder production, mostly corn and sorghum type and their half-breeds are cultivated (Iptas *et al*., 1997; Kiliç, 1986). Besides corn silage having a higher energy level compared to sorghum silage (Grant and Stock, 1995), it is reported to be in a better condition in terms of digestibility and fodder value (Grant and Stock, 1995; Bakici and Demirel, 2004). Corn within silo fodders is considered an ideal silo fodder for its productivity level and having high levels of easily soluble carbohydrate contents (Bilgen *et al*., 1997).

Urea and molasses are widely used to increase nutrient content, digestibility and consequently feed value of various silages, particularly corn (Kiliç, 1986; Undersander *et al*., 1990; Filya, 2003).

Aim of this study was to evaluate the effects of ensiling corn harvested at the milk stage by addition of various amount of urea, molasses, urea×molasses on quality *in vitro* organic matter digestibility and metabolic energy value.

MATERIALS AND METHODS

In the corn harvested at the milk stage Control (C) and according to weight structure, by adding 0.5, 1 and 1.5% Urea (U); 5, 10 and 15% Molasses (M) and 0.5 U×5% M, 1% U×5% M, 1.5% U×5% M, 0.5% U×10% M, 1% U×10%M, 1.5% U×10% M, 0.5% U×15% M, 1% U×15% M, 1.5% U×15% M, Urea×Molasses (U×M), 16 different silage samples were prepared. From each sample with 5 repetition totally 80 silage sample were incubated for 70 days in 1 L glassware jars.

Proceeding the fermentation, by extracting liquid out of silage samples (Hart and Horn, 1987), silage pH's and organic acid analysis were made. Acetic, propionic and butyric acid analysis were made in Gas Chromatography device (Dawson and Mayne, 1995), lactic acid analysis in Spectrophotometer by using lactate kit (RANDOX).

In the opened silages, flieg points and quality classifications were determined according to Kiliç (1986). CP, DM and CF analysis of the silages were made according to Weende Analysis system (Bulgurlu and Ergül, 1978). Van Soest *et al.* (1991) method were used to analysis ADF and NDF (Table 1).

Tilley and Terry's (1963) procedure were used to determine *in vitro* Organic Matter Digestibility (IVOMD) and Metabolic Energy (ME) values of silage samples. Ruminal ingesta from an alfalfa fed ruminally fistulated ram was hand-collected and strained through four layers of cheesecloth to provide the inoculate for IVOMD determination.

Statistical analysis of the data's found were made according to factorial trying pattern designed in random partitions (Düzgünes *et al*., 1987) and mathematical model below was used.

$$Y_{ujk} = \mu + a_i + b_j + (ab)_{ij} + e_{ujk}$$

Corresponding Author: Sibel Çelik, Department of Animal Science, Faculty of Agricultural, Yuzuncu Yil University, Van, Turkey

Table 1: Chemical compositions (DM%), flieg points and quality classification of different additional silages

Silages	DM (%)	CP (%)[1]	CF (%)	ADF	NDF	Flieg point	Quality classify
C	22.92	2.45	1.23	38.29	62.19	97.64	Excellent
5% M	21.74	2.95	1.29	32.61	60.53	92.36	Excellent
10% M	24.49	2.87	1.37	31.70	56.27	106.28	Excellent
15% M	22.83	2.87	1.37	32.05	57.31	105.14	Excellent
0.5% U	22.43	3.41	1.41	36.22	61.78	95.14	Excellent
1% U	22.64	3.07	1.27	34.56	63.46	100.76	Excellent
1.5% U	22.09	3.39	1.24	36.17	64.34	93.58	Excellent
0.5% U + 5% M	24.69	3.16	1.36	33.78	59.53	105.42	Excellent
0.5% U + 10% M	23.98	3.11	1.07	34.03	61.03	95.20	Excellent
0.5% U + 15% M	21.92	3.62	1.29	34.37	61.61	89.40	Excellent
1% U + 5% M	23.78	2.48	1.36	33.06	60.23	104.30	Excellent
1% U + 10% M	23.72	3.52	1.26	34.61	60.64	91.80	Excellent
1% U + 15% M	23.11	3.74	1.22	34.39	60.33	102.82	Excellent
1.5% U + 5% M	24.79	3.08	1.35	33.44	58.26	98.38	Excellent
1.5% U + 10% M	23.03	3.67	1.29	31.59	57.81	106.74	Excellent
1.5% U + 15% M	23.72	3.02	1.21	34.61	55.90	105.07	Excellent

[1]Fresh material; C: Control; U: Urea, M: Molasses

Where:

Y_{ijk} = Observed random value
μ = Grand mean
a_i = The effect of ith additions
b_j = The effect of jth doses
$(ab)_{ij}$ = Effect rate of the interactions
e_{ijk} = Random residual term

SAS (1998) was used for data analysis, which is least squares mean, analysis of variance and Duncan multiple range (Düzgünes *et al*., 1987) test used for pair wise comparison of mean of silage groups.

RESULTS AND DISCUSSION

The dry matter contents of the corn harvested at the milk stage was found to be 22.92%. Addition of urea, molasses, urea× molasses did not effect the silage's food stuff ingredients and flieg points and best quality of silages were produced (Table 1). High correlation was found between silo fodder and quality class (Alcicek and Özkan, 1997).

The effects of urea, molasses and urea×molasses on mean pH, lactic, propionic, butyric acid concentrations and ME value of silages were not significant, but on acetic acid and IVOMD were significant ($p<0.01$, $p<0.05$), respectively. When doses of urea, molasses and urea×molasses were considered the doses affected pH, lactic, acetic acid, IVOMD and ME values ($p<0.01$) and butyric acid concentrations ($p<0.05$).

Silage pH values found range between 3.61 and 4.02 (Table 2). As different urea doses had no effect on the pH of the control silage, 10 and 15% molasses addition decreased the pH ($p<0.01$). The effects of urea×molasses doses displayed no regular change. It was reported that silage pH level changed depending on dry matter content of silage material. For the best silage the pH value ranged 3.5-4.2 and organic acid level, especially lactic acid levels associated with silage quality (Kiliç, 1986; Alçiçek and Ozkan, 1997; Meeske *et al*., 2000).

Although, the lowest lactic acid concentration (1.35%) was observed at 1.5% U silage groups and also it similar to level observed from control silage (2.25%), it was found out to be lower than the 1% U silage group, which highest lactic acid concentration (2.98%) was observed ($p<0.01$).

The effects of urea and molasses on mean acetic acid concentrations were significant; but urea×molasses mixture groups increased acetic acid concentration from 2.32-4.66% ($p<0.05$). Increasing of urea and molasses doses did not change the acetic acid concentration. Urea and molasses joining silages together generally increased the acetic acid concentration. The highest acetic acid concentration was determined in 0.5 U×15% M silage (6.30%). As the highest butyric acid concentration was (1.03%) observed from 1% U×15% M silage, the lowest concentration (0.30%) was determined in 0.5% U silage ($p<0.01$). The increasing doses of urea and molasses had no effect on butyric acid concentration.

pH level and organic acid concentrations of silages are the most important characters of silage fermentation quality (Kiliç, 1986; Filya, 2000). While, urea or urea×molasses addition increase silage pH, acetic and butyric acid concentration levels, it also reported to have no effect on lactic and propionic acid (Demirel *et al*., 2003). In another study, carried out by Demirel *et al*. (2004), it was reported that urea or urea plus molasses applications increased the concentrations of acetic and lactic acid, but did not affect the butyric acid concentration. Çerçi *et al*. (2001) also mentioned that with 0.5% urea addition to silages, the concentration of lactic acid increased, but there was no negative effect of it on fermentation. Increasing protein levels of silages did not affect silage fermentation quality in different studies (Hart, 1990).

Table 2: Fermentation characteristics *in vitro* organic matter digestibility (DM%) and metabolic energy values (kcal kg^{-1} DM) of different corn silages

Variables	pH	Lactic acid	Acetic acid	Propionic acid	Butyric acid	IVOMD	ME
General mean			**			*	
Control (C)	3.83cde	2.25abcd	2.32Bbcd	0.06	0.78ab	59.93Bde	2.38cde
Molasses (M)	3.74	2.45	2.91AB	0.06	0.50	64.28AB	2.50
Urea (U)	3.83	2.19	2.29B	0.06	0.49	64.58AB	2.52
Urea×Molasses (U×M)	3.84	2.05	4.66A	0.14	0.63	65.05A	2.54
SEM	0.02	0.07	0.25	0.03	0.04	0.59	0.02
Addition doses	**	**	**		*	**	**
5% M	3.94abc	2.74abc	1.89cd	0.00	0.52ab	65.36abcd	2.55abcd
10% M	3.69fg	1.68abcd	1.88cd	0.01	0.32b	65.87abcd	2.59abcd
15% M	3.64fg	2.93ab	4.74abcd	0.16	0.67ab	61.62cde	2.38cde
0.5% U	3.87bcd	2.25abcd	1.91cd	0.02	0.30b	59.77de	2.34de
1% U	3.75def	2.98a	2.49bcd	0.08	0.52ab	71.11a	2.77a
1.5% U	3.89abc	1.35d	2.48bcd	0.08	0.69ab	62.87cde	2.46bcde
0.5% U×5% M	3.77def	2.51abcd	6.06ab	0.09	0.83ab	69.85ab	2.71ab
0.5% U×10% M	3.94abc	2.35abcd	4.42abcd	0.04	0.41ab	60.32de	2.35de
0.5% U×15% M	3.99ab	2.34abcd	6.30a	0.11	0.44ab	64.30bcd	2.51abcd
1% U×5% M	3.71efg	1.64bcd	4.12abcd	0.33	0.61ab	65.70abcd	2.56abcd
1% U×10% M	4.02a	1.67abcd	5.74abc	0.25	0.69ab	57.25e	2.23e
1% U×15% M	3.71efg	2.13abcd	5.49abc	0.08	1.03a	65.89abcd	2.57abcd
1.5% U×5% M	3.91abc	2.31abcd	5.67abc	0.14	0.75ab	67.29abc	2.63abc
1.5% U×10% M	3.61g	1.92abcd	2.49bcd	0.06	0.53ab	64.89abcd	2.54abcd
1.5% U×15% M	3.69fg	1.54cd	1.82d	0.19	0.42ab	69.96a	2.73a
SEM	0.03	0.09	0.22	0.08	0.04	0.58	0.02

*$p<0.05$, **$p<0.01$; Values with different letters in the same column differ significantly A, B ($p<0.05$); a-e ($p<0.01$)

Generally, the effects of U, M and U×M on mean IVOMD and ME values of silages were not affected, when doses of U, M and U×M were considered, the differences among doses were statistically significant ($p<0.05$). The highest IVOMD and ME value was determined in 1% U additional silage group. This situation could be explained by the effect of urea, which was used in silage fermentation on the structural carbohydrates in cell wall (ADF and NDF); while urea increased the degradability of DM, OM, ADF and NDF, it decreased the level of NDF and ADF in cell wall. Besides, Bolsen *et al*. (1996) have reported that urea and ammoniac increases the digestibilities of DM, OM and cell wall components of silages.

IVOMD of two different corn hybrid silages ranged between 56.7 and 72.4%, ME values between 8.73 and 10.20 MJ DM^{-1} (Meeske *et al*., 2000; Garcia *et al*., 2000) and in another study, carried out by Meeske *et al*. (2002), IVOMD of the corn silage was found to be 65.4 and 70.5% in turn in order. Faria and Huber (1984) reported that increasing levels of urea on corn silage increases CP level and proportionally increases IVOMD from 57.84-62.80%.

CONCLUSION

As a result, satisfied silages were obtained in terms of fermentation properties. However, it should be concluded that unsupplemental or 1% U could be preferred when silage fermentation quality, organic matter digestibility and ME values are taken into consideration.

REFERENCES

Alçiçek, A. and K. Özkan, 1997. Determination of silage quality with physical and chemical methods in silages. Turkey I. Silage Congress, Sep. 16-19, Bursa, pp: 241-246.

Bolsen, K.K., G. Ashbell and Z.G. Weinberg, 1996. Silage fermentation and silage additives. AJAS, 9 (5): 483-493. http://grande.nal.usda.gov/ibids/index.php?mode2=detail&origin=ibids_references&therow=400106.

Bakici, Y. and M. Demirel, 2004. Determination of qualities of corn, sorghum, sudangrass and sorghum x sudangrass hybrid silages. J. Appl. Anim. Res., 26 (1): 45-48. www.cababstractsplus.org/abstracts/Abstract.aspx?AcNo=20043193504.

Bilgen, A., A. Alçiçek, N. Sungur, P. Eichhorn and O.P. Walz, 1997. A research on effects silage quality and food value of grain crusher in the corn silage machine. Turkey I. Silage Congress, Sep. 16-19, Bursa, pp: 52-60.

Bulgurlu, S. and M. Ergül, 1978. Analysis methods physical, chemical and biological of feeds. Ege University Basimevi Yayin No.: 127, Izmir, pp: 176.

Çerçi, I.H., P. Tatli, F. Gürdogan and N. Birben, 2001. The effects on the digestibility nutrient matters and silage quality of urea supplementation of corn harvested in different vegetational periods. I. National Animal Nutrition Congress, Agu. 29-Sep 02, Elazig, Turkey.

Dawson, L.R. and S.C., Mayne, 1995. The effect of addition of mixtures of amino acids on the intake of grass silage by sheep and cattle. J. Sci. Food and Agric., 77 (3): 404-406. DOI: 10.1002/(SICI)1097-0010 (199807)77:3<404::AID-JSFA56>3.0.CO;2-Y.

Demirel, M., I. Yilmaz, S. Deniz, O. Kaplan and H. Akdeniz, 2003. Effect of addition of urea or plus molasses to different corn silages harvested at dough stage on silage quality and digestible dry matter yield. J. Appl. Anim. Res., 24 (1): 7-16.

Demirel, M., S. Deniz, I. Yilmaz and H. Nursoy, 2004. The effects of adding urea or urea + molasses in some sorghum varieties harvested at dough stage on silage quality and digestible dry matter yield. Turk. J. Vet. Anim. Sci, 28 (1): 29-37. http://journals.tubitak.gov.tr/veterinary/issues/vet-04-28-1/vet-28-1-5-0201-14.pdf.

Düzgünes, O., T. Kesici, O. Kavuncu and F. Gürbüz, 1987. The research and experiments methods. Ankara Üniversity Zir. Fak. Yay. 1021, Ankara, Turkey.

Faria, D.V.P. and J.T. Huber, 1984. Effect of dietary protein and energy levels on rumen fermentation in Holstein steers. J. Anim. Sci., 58: 452-459. PMID: 670-6877.

Filya, I., 2000. Using of additives matters at silage fermentation. Ondokuz Mayis Üniversity Ziraat Fak. Dergisi, 15 (3): 118-125.

Filya, I., 2003. The effects on aerobic stability and microbial flora of wheat, corn and sorghum silages of organic acides. III. National Zootechnia Science Congress, Oct. 14-16, Ankara, pp: 299-308.

Grant, R. and R. Stock, 1995. Harvesting corn and sorghum for silage. NebGuide; Published by Cooperative Extention, Institute of Agriculture and Natural Resources, University of Nebreska, Lincoln; http://www.ianr./un/edu/pubs/range.1-8.

Garcia, S.C., F.J. Santini and J.C. Elizalde, 2000. Sites of digestion and bacterial protein synthesis in dairy heifers fed fresh oats with or without corn or barley grain. J. Dairy Sci., 83: 746-755.

Hart, S.P. and F.P. Horn, 1987. Ensiling characteristics and digestibility of combinations of turnips and wheat straw. J. Anim. Sci., 64: 1790-1800. http://jas.fass.org/cgi/reprint/64/6/1790.pdf.

Hart, S.P., 1990. Effects of altering the grain content of sorghum silage on its nutritive value. J. Anim. Sci., 68: 3832-3842.

Iptas, S., M. Yilmaz, A. Öz and R. Avcioglu, 1997. Utilization possibilities from silage corn, sorghum and hybrids in Tokat ecological conditions. Turkey I. Silage Congress, Sep. 16-19, Bursa.

Kiliç, A., 1986. Silage (Suggestion for Education, Instruction and Application). Bilgehan Basimevi, Izmir, pp: 327.

Meeske, R., H.M. Basson, J.P. Pienaar and C.W. Cruywagen, 2000. A comparison of the yield, nutritional value and predicted production potential of different maize hybrids for silage production. South Afr. J. Anim. Sci., 30 (1): 18-21. http://search.sabinet.co.za/ejourpdf/sajas/sajas_v30_n1_a4.pdf.

SAS, 1998. SAS® User's guide: Statistics, Version 8. SAS Institute Inc., Cary, NC.

Tilley, J.M.A. and R.A. Terry, 1963. A two-stage technique for the *in vitro* digestion of forage crops. J. Br. Grassl. Soc., 18 (2): 104-111.

Undersander, D.J., L.H. Smith, A.R. Kaminski, K.A. Kelling and J.D. Doll, 1990. Sorghum-Forage. Alternative Field Crops Manual, pp: 2-10. http://newcrop.hort.purdue.edu.

Van Soest, P.J., J.B. Robertson and B.A. Lewis, 1991. Methods of dietary fiber, neutral detergent fiber and nonstarch polysaccharides in relation to animal nutrition. J. Dairy Sci., 74: 3583-3597. http://jds.fass.org/cgi/reprint/74/10/3583. PMID: 1660498.