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Research Article

Effects of Urea or Urea plus Molasses Supplementation to Silages with Different Sorghum Varieties Harvested at the Milk Stage on the Quality and In Vitro Dry Matter Digestibility of Silages*

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Abstract: The objective of this study was to evaluate the effects of 0.5% urea and 0.5% urea plus 4% molasses (on weight basis) addition to sorghum silages ensiled using 4 sorghum varieties (Grass II, Grazer, Gözde, and P-988) harvested at the milk stage. Plant materials were ensiled in 1-kg jars and the chemical composition, pH, organic acids, in vitro digestibility (IVDMD) and digestible dry matter yield (DDMY) of the silages were determined. Addition of urea and urea plus molasses to silages increased the crude protein ratio significantly ($P < 0.01$). However, the addition of urea plus molasses significantly decreased the neutral detergent fiber and acid detergent fiber contents of the silages. Additives significantly increased the pH values of the silages. The addition of urea and urea plus molasses to silages generally did not affect acetic or propionic acid content; however, the butyric acid content of the urea and urea plus molasses groups was higher than that of the control groups. IVDMD of all sorghum varieties decreased with the addition of urea and urea plus molasses. Additives did not affect DDMY. In conclusion, the addition of 0.5% urea and 0.5% urea plus 4% molasses to sorghum silages, harvested at the milk stage, improved the CP content of the silages, but they had no positive effect on silage quality, IVDMD or DDMY.

Key Words: Sorghum silage, sorghum varieties, silage quality, in vitro digestibility

Süt Oluşum Döneminde Hasat Edilmiş Farklı Sorgum Varyetelerinden Elde Edilen Silajlara Üre veya Üre ve Melas Katkısının Silaj Kalitesi ile İn Vitro Kuru Madde Sindirilebilirliği Üzerine Etkileri

Özet: Bu araştırmanın amacı süt olum döneminde hasat edilen dört farklı sorgum varyetesinden (Grass II, Grazer, Gözde ve P–988) elde edilen silajlara % 0,5 üre veya % 0,5 üre ve % 4 melas katkısının etkilerini belirlemektir. Bitki materyalleri 1 kg'lık kavanozlarda silaj yapılmış ve silajın kimyasal bileşim, pH, organik asitler, iv vitro sindirilebilirlik (IVDMD) ve sindirilebilir kuru madde verimleri (DDMY) tespit edilmiştir. Silaja üre veya üre ve melas katkısı ham protein oranını önemli derecede ($P < 0,01$) artırmıştır. Bununla birlikte, üre ve melas katkısı silajın NDF ve ADF içeriğini önemli derecede azaltmıştır. Ayrıca katkı maddeleri silajın pH değerini artırmıştır. Silaja üre veya üre ve melas katkısı genellikle sorgum silajlarının asetik ve propiyonik asit içeriğini etkilememiştir. Bununla birlikte üre veya üre ve melas gruplarının bütirik asit içeriği kontrol gruplarından daha yüksek olmuştur. Bütün sorgum çeşitlerinin in vitro kuru madde sindirilebilirliği üre veya üre ve melas katkısıyla azalmıştır. Katkılar (üre veya üre ve melas) sindirilebilir kuru madde verimini etkilememiştir. Sonuç olarak, süt olum döneminde hasat edilen sorgumlardan elde edilen silajlara % 0,5 üre veya % 0,5 üre ve % 4 melas katkısı silajın protein içeriğini iyileştirmiştir, ancak silaj kalitesi, in vitro kuru madde sindirilebilirliği ve sindirilebilir kuru madde verimi üzerine pozitif bir etki yapmamıştır.

Anahtar Sözcükler: Sorgum silajı, sorgum çeşitleri, silaj kalitesi, in vitro sindirilebilirlik

Introduction

Sorghum is best suited to warm, fertile soils and tolerates drought relatively well (1). Therefore, it typically produces less dry matter (DM) yield per hectare compared to corn under irrigation, but it produces more DM and energy yields per hectare than corn on dry land (2), indicating that sorghum may be preferred over corn for silage in areas where the climate is not well suited to corn production. Furthermore, improved sorghum hybrids often give DM yields comparable to corn with

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lower production costs today, but there are often large variations among sorghum hybrids (3). In addition to varieties, stage of maturity is another factor affecting sorghum silage (4) and is important mainly for 2 reasons: maximum digestible nutrient production (5), and moisture content for proper ensiling (2,3). Molasses and urea are used as silage additives. Silage protein content can be increased and proteolysis decreased with the addition of urea (6). Decreased silage pH and improved silage quality can be achieved with the addition of molasses, which is used up to a maximum of 6% in silage materials (7).

The objective of this study was to evaluate the effects of 0.5% urea and 0.5% urea plus 4% molasses (on weight basis) supplementation to sorghum silages ensiled using 4 sorghum varieties (Grass II, Grazer, Gözde and P-988) harvested at the milk stage for Eastern Anatolia conditions.

Materials and Methods

Grass-II, Gözde, Grazer, and P-988 sorghum cultivars were harvested at the milk stage, chopped, and 3 treatment groups were formed: control, 0.5% urea, and 0.5% urea plus 4% molasses. In total 36 silage samples (4 cultivars, 3 treatment groups, and 3 replications) were put into 1- kg jars and were pressed. The lids of the jars were punched and jars were put lid-side down on the floor for 48 h to drain out excess water. The jars were opened after 90 days and the pH level of the silages was measured immediately. Using Whatman 54 filter paper silage liquid was filtered and stored in a deep freeze until it was analyzed. Organic acid analyses were performed according to the method described by Leventini et al. (8) using gas chromatography. Crude protein (CP) analyses of silage samples were conducted using wet samples. DM and CP were analyzed by Weende's method (9). Van Soest and Robertson's (10) method was used to analyze acid detergent fiber (ADF) and neutral detergent fiber (NDF). Tilley and Terry's (11) methods (later modified by Marten and Barnes (12)) were used to determine in vitro dry matter digestibility (IVDMD) of silage samples. Ruminal ingesta from an alfalfa-fed ruminally fistulated ram was hand-collected and strained through 4 layers of cheese cloth to provide the inoculate for IVDMD determination.

The SPSS (1999) for Windows program was used for the statistical analysis (13). Treatment means were separated with Duncan's test at P < 0.05 (14).

Results

Average main factor effects are shown in Tables 1 and 2, and significant interaction effects (varieties and additives) are shown in Figures 1-4.

Table 1. Chemical composition and pH values of different sorghum silages (% of DM).

Varieties	DM	OM	CP	NDF	ADF	pH
Grass-II	29.29 ^{b}	90.21	11.45 ^{bc}	63.50 ^{b}	39.65 ^{b}	4.60 ^{b}
Grazer	30.59 ^{ab}	91.51	10.88 ^{c}	65.04 ^{b}	37.07 ^{b}	4.57 ^{b}
Gözde	31.86 ^{a}	91.49	12.55 ^{a}	71.53 ^{a}	44.60 ^{a}	5.62 ^{a}
P-988	31.34 ^{a}	91.07	12.14 ^{ab}	65.37 ^{b}	39.83 ^{b}	4.69 ^{b}
Additives						
Control	30.50 ^{b}	93.02 ^{a}	8.06 ^{b}	69.40 ^{a}	41.30 ^{a}	4.23 ^{c}
Urea	29.46 ^{b}	89.37 ^{b}	13.80 ^{a}	67.93 ^{a}	40.68 ^{a}	5.54 ^{a}
Urea plus molasses	32.35 ^{a}	90.83 ^{b}	13.40 ^{a}	61.75 ^{b}	38.87 ^{b}	4.84 ^{b}
Varieties	**	ns	**	**	**	**
Additives	**	**	**	**	*	**
Interactions	ns	ns	ns	ns	**	ns

a-c: Values with different superscripts in the same column differ significantly
* P < 0.05, ** P < 0.01, ns: not significant

Table 2. Organic acids and IVDMD (% of DM) and digestible DM yield (kg/ha) of different sorghum silages.

Varieties	Acetic Acid	Propionic Acid	Butyric Acid	Lactic Acid	IVDMD (%)	DMMY (kg/ha)
Grass-II	0.65 [a]	0.16 [ab]	1.12 [a]	3.23 [a]	49.99 [a]	73.2 [b]
Grazer	0.49 [b]	0.12 [b]	0.46 [b]	3.39 [a]	51.05 [a]	87.4 [ab]
Gözde	0.50 [b]	0.20 [a]	1.49 [a]	1.85 [b]	46.45 [b]	72.3 [b]
P-988	0.54 [b]	0.16 [ab]	0.26 [b]	2.03 [b]	51.38 [a]	97.2 [a]
Additives						
Control	0.54	0.16	0.36 [b]	4.43 [a]	54.19 [a]	89.5
Urea	0.49	0.19	1.27 [a]	1.02 [c]	45.79 [c]	76.7
Urea plus molasses	0.60	0.14	0.87 [a]	2.42 [b]	49.17 [b]	81.4
Varieties	**	**	**	**	**	*
Additives	ns	ns	**	**	**	ns
Interactions	**	*	**	ns	ns	ns

a-c: Values with different superscripts in the same column differ significantly
* $P < 0.05$, ** $P < 0.01$, ns: not significant

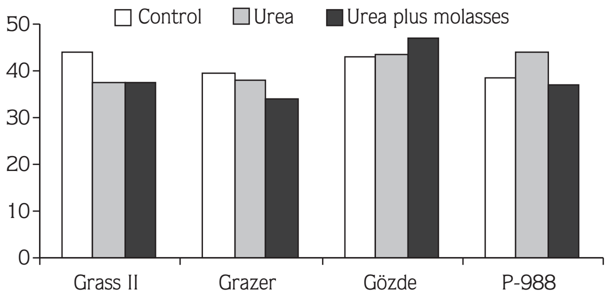

Figure 1. ADF content of sorghum silages.

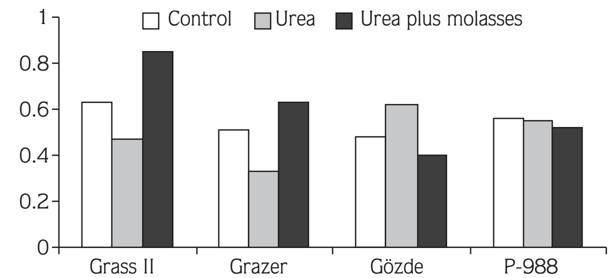

Figure 2. Acetic acid of sorghum silages.

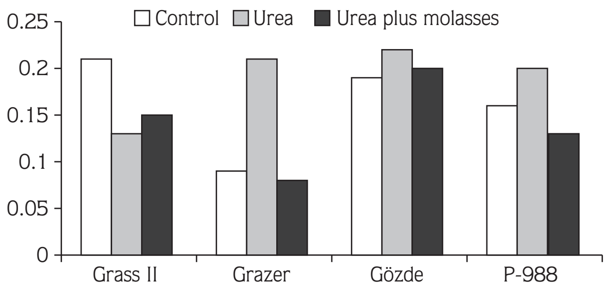

Figure 3. Propionic acid of sorghum silages.

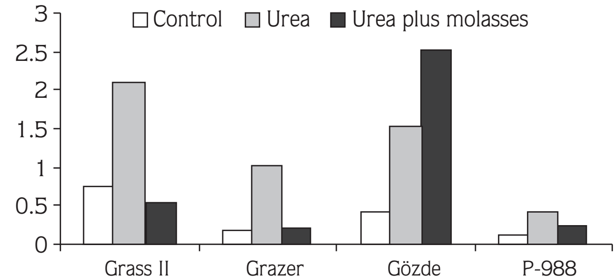

Figure 4. Butyric acid of sorghum silages.

Silage DM content generally increased with the addition of urea plus molasses. Urea did not affect DM content compared to the control ($P < 0.01$; Table 1). The highest DM content was obtained in Gözde, P-988 and Grazer (31.86, 31.34 and 30.59, respectively). The OM content of silages significantly decreased with the addition of urea and urea plus molasses ($P < 0.01$). The addition of urea and urea plus molasses significantly increased the CP contents of sorghum silages ($P < 0.01$). The highest CP content was found in Gözde and P-988

(Table 1, P < 0.01). Urea plus molasses significantly decreased the NDF contents of silages compared with the control (Table 1, P < 0.01). The highest NDF content of silages was obtained in Gözde. The addition of molasses significantly decreased ADF contents compared to the control and urea addition (P < 0.05). The ADF content of Gözde was the highest of the 4 varieties (Table 1 and Figure 1). The addition of urea and urea plus molasses significantly increased the pH values of silages compared to the control (Table 1; P < 0.01), but urea addition increased the pH of silages more than did urea plus molasses. Additives did not affect the acetic or propionic acid contents of silage, but generally the butyric acid content increased (P < 0.01). Lactic acid contents of the silage were significantly decreased by silage additives compared to the control (Table 2; P < 0.01). While the acetic acid content in Gözde increased with urea addition, the acetic acid content in Grass II and Grazer increased with urea plus molasses addition (Figure 2). On the other hand, while the butyric acid content was higher with urea addition in Grass II, Grazer, and P-988, it was higher in Gözde with the addition of urea plus molasses (Figure 4). While the propionic acid content of silages was greatest in Grass II in the control treatment, it was greatest in Grazer, Gözde, and P-988 with the addition of urea (Figure 3).

IVDMD decreased with urea and urea plus molasses addition (45.79 and 49.17, respectively) (Table 2; P < 0.01). Additives did not affect the digestible DM yield of the silages (Table 2).

Discussion

Silage DM content increased with the addition of urea plus molasses (Table 1). In contrast, OM content generally decreased in the urea and urea plus molasses groups. Bolsen et al. (15) and Nursoy et al. (16) reported similar results. A decrease in organic matter content arises from an increase in soluble carbohydrates during ensiling in the urea and molasses groups. The addition of urea to sorghum silages significantly increased CP content (P < 0.01). This result is similar to those reported by Bolsen et al. (15) and Hinds et al. (17). The NDF contents of all sorghum silages significantly (P < 0.01) decreased in the urea and urea plus molasses groups. Molasses addition decreased the ADF contents of sorghum silages (P < 0.05). Generally, the NDF and ADF contents in sorghum silages with the addition of urea plus molasses decreased. Researchers have suggested 2 reasons for this decrease. First, the addition of molasses to silages increases the number of aerobic bacteria, including the lactic acid bacterium; therefore, the NDF and ADF degradation of silages increases (18). Second, a decrease takes place because of the lower ADF content of the additives (19).

The pH of silages increased with the addition of urea (Table 1). Sarwatt et al. (20) and Berger et al. (6) stated that the addition of urea in sorghum silages increases silage pH. High quality silage has 3.5-4.5 pH (21). The acetic acid concentrations of all the sorghum silages, expect Grass-II silage, did not differ from those of the control groups. While Bolsen et al. (15) and Singh et al. (22) reported that the addition of urea to sorghum silage increases the concentration of acetic acid, Hinds et al. (17) reported that it had no effect. The propionic acid content generally did not differ compared to the control. However, the butyric acid content of the urea and urea plus molasses groups was higher than that of the control groups. This result was similar to the findings reported by Sarwatt et al. (20). It is known that lactic acid content in silages increase with the addition of molasses (15,17,18). In contrast, in the present study, it generally decreased. This can be explained by the buffer capacity of silages increasing with the addition of urea (6).

The addition of urea and urea plus molasses to silages decreased IVDMD compared to the control (Table 2). This result can be attributed to increasing organic matter (soluble carbohydrates) losses in the urea and molasses groups. Additives did not affect digestible DM yield (Table 2). According to Snyman and Joubert (23), the bloom stage (DM = 24.6%) was the optimum harvesting stage, at which maximum amounts of DM, IVDMD, and CP were produced per hectare. Grant et al. (24) found a 160 kg/ha DM forage sorghum yield; however, in the present study, DM yields of the sorghum varieties were 146.6-189.3 kg/ha.

In conclusion, the addition of 0.5% urea and 0.5% urea plus 4% molasses to sorghum silages, harvested at the milk stage, improved the CP content of silages, but had no positive effects on silage quality, IVDMD or digestible DM yield.

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