The Effect of Variety on the Chemical Composition and Ensiling Characteristics of Sorghum Plant

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Abstract: The aim of the current study was to determine the effect of variety on the ensiling characteristics and composition of sorghum silage. Experiments were carried out in randomized block design with 3 replications in Kahramanmaras, Turkey. Sorghum plant harvested at dough stage was ensiled in plastic silo. After ensiling of sorghum for 60 days the chemical composition and fermentation of the resultant silages parameters were determined. The CP values of genotypes varies between 6.76 to 10.70%, NDF between 47.82,and 61.06 ADF between 30.51 and 44.04%,.The lactic acid and butyric acid contents ranged from 19.00 to 44.38 and 2.14 to 4.48 g/kg DM, respectively. The fleig score ranged from 90.21 to 97.11 as a conclusion, the variety had a significant effect on the chemical composition and fermentation parameters of the resultant sorghum silages.
Keywords: Sorghum, silage, nutritive value, chemical composition,

Çeşidin Sorghum Bitkisinin Silolanma Karekteristiklerine ve Kompozisyonuna Etkisi

Özet : Bu çalışmanın amacı, çeşidin sorgum bitkisinin silolanma karektereristiklerine ve kompozisyonuna etkisi belirlemektir. Araştırma Kahramanmaraş'ta yürütülmüş ve bitkiler hamur olum döneminde hasat edilmiştir. Deneme tesadüf blokları deneme desenine göre 3 tekrarlamalı olarak kurulmuş olan bu deneme Kahramanmaraş'ta yürütülmüştür. Bitkiler hamur olum döneminde hasat edilerek küçük plastik bidonlarda silolanmıştır. Altmış günlük silolama süresinden sonra elde edilen silajların kompozisyonları ve fermantasyon parametreleri belirlenmiştir. Beş sorgum çeşidinin (ICSB 502, ROX, SC 941 ICSB 564 ve B24) kullanıldığı araştmada, ham protein oranı, kuru madde oranı, ham kül, ADF, NDF, fleig puanı, pH ve uçucu yağ asitleri incelenmiştir. Silajların ham protein içerikleri %6.7 ile 10.70, NDF içeriği %47.82 ile 61.06, ADF oranı %30.51 ile 44.04, laktik asit içeriği 19.00 ile 44.38 g/kg/DM, butirik asit içeriği 2.14 ile 4.48 g/kg DM arasında değişmiştir. Silajların Fleig skoru ise 90.21 ile 97.11 arasında değişmiştir. Sonuç olarak, çeşit oluşan silajların kompozisyonu ve fermantasyon parametrelerini önemli derecede etkilemiştir. Çalışmada kullanılan örnekler içinden SC 941 besleme özelliği yönünden bölge için uygun bir çeşit olarak önerilmektedir.
Anahtar Sözcükler: sorgum, silaj, besleme değeri, kimyasal kompozisyon

INTRODUCTION

Silage is a significant feedstuff to meet protein, energy, mineral and fiber needs of ruminant animals. Silage is produced by using different plants such as cereals and legumes. Corn, sorghum, wheat and barley are the most common silage crops used as feed source for livestock. Sorghum silage is increasing all around the world due to high productivity and drought tolerance of sorghum even it has lower digestibility than corn silage (Sanchez et al 2002; Hibbert et al, 1982).

Forage yield, ensilage losses and silage nutritive quality of sorghum varieties may also be affected by genotypes. And, there is still only fragmentary knowledge in the literature about the participation of sorghum cell wall polysaccharides and water-soluble carbohydrate (WSC) throughout the ensilage process and the profile of consequent fermentation products (Miron et al, 2006).

Various hybrids and varieties of sorghum differ in their chemical composition, including content of water-soluble carbohydrate (WSC) and protein, as well as in their structural fibrous fractions, including NDF and ADF. Consequently, considerable differences between varieties with respect to dry matter and NDF digestibility of the silage were observed by the researchers (Hanna et. al., 1981; Ashbell et. al., 1999). Therefore, the aim of the current study was to determine the effect of variety on the ensiling characteristics and composition of sorghum silage

MATERIAL and METHOD

Material

In this research, sorghum cultivars of SC941 and B24 from Texas A&M University (USA), ICSB 502 and ICSB 564 from ICRISAT (India) and ROX from Western Mediterranean Research Center (Antalya, Turkey) were used as the material.

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Method

Experimental Design

Experiments were carried out at the experimental fields of Kahramanmaras Agricultural Research Center during the summer seasons of the year 2007. Field experiments were implemented in randomized block design with 3 replications. Sorghums were sown in April and harvested at dough stage. Experimental plots were designed at 5x2.8 m with 4 rows. Row spacing was 70 cm and intra-row plant spacing was 12 cm. Samples harvested at dough stage were chopped in 2-3 cm pieces, squeezed and ensiled into jerry cans and cans were opened after 60 days of ensiling.

Soil and Climate Characteristics of Trial Area

Experimental site has sandy-clay soil texture with a pH of 7.94, lime content of 16% and low organic matter content (Table 1; Anonymous, 2008a).

Table 1. Physical and chemical characteristics of soils of experimental site

Depth (cm)	Teksture Class	pH	$CaCO_3$ (%)	P_2O_5 (kg/da)	K_2O (kg/da)	Organic Matter %
0–30	Sandy Clay	7.94	16	0.85	3.6	1.49

Total precipitation of the experimental year was 166.6 mm and the value was 15.0 mm below the long-term averages. Since the precipitations are not sufficient, plant water demands were supplied by irrigations with 7-10 day intervals. Long-term average temperature of Kahramanmaras during the experimental months is 23.1 ºC and the realized average temperature of the experimental year was above the long-term averages (24.6 ºC) (Fig.1; Anonymous, 2008b).

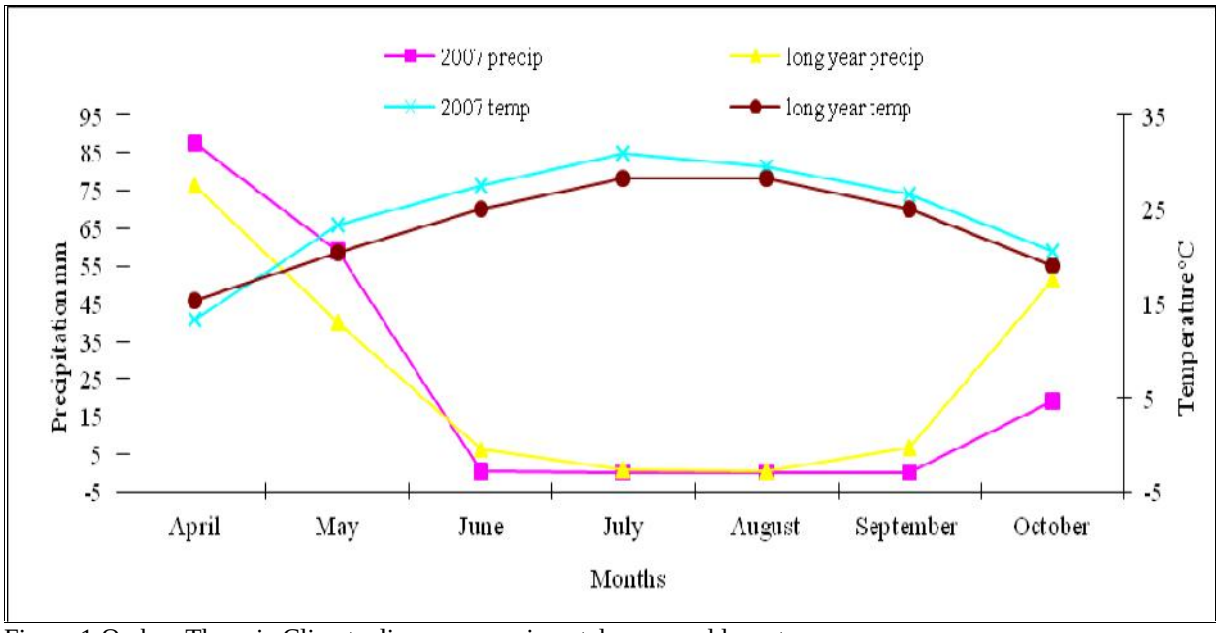

Figure 1:Ombro-Thermic Climate diagram experimental years and long-term averages

Chemical Composition

pH was measured right after opening the silages. For this purpose, 100 ml distilled water was added over 25 g silage sample and mixed in a blender, then pH of the resultant liquid was measured with a pH meter. Silage liquids obtained by filtering the samples through Whatman 54 filter paper were kept in a freezer until the organic acid analysis (Lactic, acetic, propionic and butyric acid). Organic acids analyses were performed according to the method described by Leventini et al. (1990) using by using a gas chromatographer.

Crude ash and crude protein analysis of the silage samples were carried out in accordance with AOAC, 1990, NDF Van Soest and Wine, (1967) and NDF and ADF contents of silages were determined according to the method described by Van Soest, (1963).

Fleig scores of the silages were calculated according to Kilic, 1984 by using the formula below;

Fleig scores = 220 + (2 × DM % -15) - (40 × pH)

Where, Fleig scores of 85-100 denote “very good quality”; 60 - 80 denotes “good quality”; 55 - 60 “moderate quality”; 25 - 40 “satisfying quality”; and <20 “worthless”.

Statistical Analysis

Variance analysis of experimental results was carried out by using SAS (SAS Inst., 1999) software. LSD test was used to evaluate the significance of differences among the averages.

RESULTS

The effect of variety on the chemical compositions of resultant sorghum silage genotypes were presented in Table 2. The variety had a significant (P<0.01) effect on the chemical compositions of resultant sorghum silage.

The dry matter contents of the resultant silages ranged from 20.93 to 30,75%. The variety of SC942 had significantly higher (P<0.01) dry matter content than the others. The crude protein contents of the resultant silages ranged from 6.76 to 10.70%. The variety of B24 had a significantly higher crude protein then the others. The NDF and ADF contents of the resultant silages ranged from 47.82 to 61.06% and 30.51 to 44.02 % respectively. The variety of ROX had a significantly higher NDF and ADF contents then the others.

Except for the acetic acid content, the variety had a significant (P<0.01) effect on the fermentation parameters of resultant sorghum silage. Lactic acid content of the resultant sorghum silages ranged from 19.00 to 44.3 g/kg DM. The variety of ICSB 502 had significantly higher lactic acid content then the others. Butyric acid content of the resultant sorghum silages ranged from 2.14 to 4.48 g/kg DM. The variety of ICSB 564 had significantly higher lactic acid content then the others.

The pH of the resultant sorghum silage ranged from 3.79 to 4.24 (Table 3). The variety of SC 941 had significantly higher pH then the others. Fleig score of the resultant sorghum silage ranged from 90.21 to 97.11. The ICSB 564 had significantly lower Fleig score then the others.

Table 2. The chemical composition of silage sorghum variety

Nutrients (%)	Variety					LSD	Sig.
	ICSB 502	ROX	SC 941	ICSB 564	B24		
DM	25.74 c	20.93 e	30.75 a	24.34 d	26.86 b	0.86	**
CP	9.00 b	6.76 d	8.66 b	8.13 c	10.70 a	0.45	**
Ash	10.42 b	10.96 a	9.73 c	10.91 a	9.88 c	0.39	**
NDF	50.74 c	61.06 a	47.82 d	54.38 b	50.51 c	1.54	**
ADF	35.50 d	44.02 a	30.51 e	40.08 b	36.56 c	0.92	**

a b c d e Row means with common superscripts do not differ (P>0.05); ***LSD:*** *Least Significant Difference;* ***Sig.:*** *significance level; ** P<0.01;* ***DM :****Dry matter %,* ***CP :****Crude protein;* ***NDF :****Neutral detergent fiber,* ***ADF :****Acid detergent fiber*

Table 3. Fermentation characteristics and fleig scor of silage sorghum variety

Parameters g/kg/DM	Variety					LSD	Sig.
	ICSB 502	ROX	SC 941	ICSB 564	B24		
Lactic	44.38 a	21.01c	33.94 b	32.84 b	19.00 d	1.15	**
Asetic	4.10	3.30	4.46	3.28	3.89	1.45	NS
Propiyonic	4.51 c	8.40 a	2.71 e	3.76 d	7.64 b	0.51	**
Butiric	3.40 b	3.27 b	2.59 c	4.48 a	2.14 c	0.52	**
pH	4.03 b	3.79 c	4.24 a	4.09 b	4.04 b	0.08	**
FS	95.41 a	95.13 a	97.04 a	90.21 b	97.11 a	3.55	**

a b c d e Row means with common superscripts do not differ (P>0.05); ***FS :*** *Fleig score;* ***LSD:*** *Least Significant Difference;* ***Sig.:*** *significance level; ** P<0.01;* ***NS:*** *non significant*

DISCUSSION

Forage quality of sorghum may strongly be affected by interactions between the genotype, the maturity stage of the plants at harvest and environmental factors (Cummins, 1981; Pedersen, 1982; Cakmakcı et al., 1999; Filya, 2004). Agronomic performance and nutritive value of forage sorghums are significantly influenced by stage of maturity at harvest Black, 1980). Such interactions among sorghum varieties were clearly observed in present study. Crude Protein ratios are usually proportional to leaves since the leaves are the main protein contributor in sorghum (Hanna et al., 1981). Crude protein ratios of current study were also at very high levels because of well-developed leaves. Similar high ratios were also reported by Oswalt, et. al., (1973): Snyman and Joubert, 1996: Kallah et al., 1999: Çakmakçi et. al., 1999: Miron, 2005)

Pholsen et al., (1998) reported NDF ratios of sorghum cultivars as between 57.14 and 66.64% and ADF ratios as between 29.81 and 35.76%. ADF and NDF ratios of present study were similar to those reported by Bolsen et al., 1985; Hinds et al., 1992 and Keskin et. al., (2005). Forage sorghums should be harvested and ensiled at dough stage. Forage sorghums typically contain less than 30% DM at dough stage (Bolsen, 2004). DM results to current study were similar to those reported by Black et. al., 1980; Bolsen, 2004; Keskin et. al., 2005; Miron,(2005). Ash content of sorghum varieties were also similar to the values reported by Flachowsky and Henning (1990), but higger than those reported by Caswell et al., 1975; Abdelmawla et al., 1988; Al-Rokayan et. at., 1998; Miron et. al., 2005; Uzun et. al., 2009).

Ensiling is a preservation method for most crops that is based on natural lactic acid fermentation under anaerobic conditions, whereby epiphytic lactic acid bacteria (LAB) convert water-soluble carbohydrates into organic acids, mainly lactic acid. Such a fermentation process decreases pH and preserve the quality of silage for long periods (McDonald et al., 1991). Danner et. al., (2003) reported the pH of sorghum silages as around 3.8, lactic acid concentrations as between 31.9 and 35.4 %. So, low pH and high lactic levels are the significant indicators of a good quality silage. The lactic acid contents of sorghum silages obtained at milk and dough stages were considerably lower than those reported by Bingol and Baytok (2003) for sorghum silages (44.73 and 33.27 g/kg DM, respectively). Findings of Al-Rokayan, 1998: Çakmakçı, 1999: Filya, 2004; Miron, 2005 were closer to outcomes of the present study.

The higher fleig score of sorghum silage at dough stage was associated with higher dry matter and low pH values since fleig score was estimated using dry matter and pH values of silages. As can be seen from the formula used to estimate fleig score, dry matter content and silage pH are positively correlated with fleig score of silages. Results of current study revealed that high quality silage could be produced from sorghum genotypes harvested at dough stage. The all sorghum silages investigated in the current experiment were placed in "very good quality" class. Therefore according to the current experiment all sorghum varieties can be recommended for silage production. However more in vivo and in vitro digestibility studies are required for conclusive suggestion for farmers. Among the investigated varieties, SC 941 could be recommended for silage with regard to silage characteristics and chemical compositions.

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