TÜRK
TARIM ve DOĞA BİLİMLERİ
DERGİSİ

TURKISH
JOURNAL of AGRICULTURAL
and NATURAL SCIENCES

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Determination of Silage Characteristics and Nutritional Values of Some Triticale Genotypes

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Received: 05.12.2013 Received in Revised Form: 27.12.2013 Accepted: 02.01.2014

Abstract

The study was conducted to determine silage characteristics and relative feed values of triticale genotypes to be used for silage. 6 different cultivars and 4 lines of triticale were used as plant material in the study. Experiment was carried out in randomized block design with 3 replications under Bingöl conditions. The experimental plots were harvested at dough stage of the plants, ensiled into 5 kg plastic jars and opened after 60 days. Results revealed that dry matter content of the silage varied between 35.54% and 41.46%, protein content between 7.34% and 10.25%, raw ash content between 5.21% and 7.19%, NDF content between 51.24% and 60.00%, ADF content between 33.93% and 39.47%, lactic acid content between 48.12 and 59.25 g kg^{-1} DM, acetic acid content between 15.41 and 19.22 g kg^{-1} DM, propionic acid between 2.86 and 4.21 g kg^{-1} DM, pH between 4.55 and 4.93, Fleig score between 78.74 and 99.48, digestibility of dry matter between 57.42% and 62.21%, dry matter intake between 1.99% and 2.30%, relative feed value between 88.55 and 110.90, depending on the genotypes. It was concluded that triticale could be used as a quality silage crop for animal feeding.

Keywords: Triticale, silage, relative feed value, volatile fatty acids, NDF

Bazı Tritikale Genotiplerinin Silaj Karakterlerinin ve Besleme Değerlenin Belirlenmesi

Özet

Bu araştırma bazı tritikale genotiplerinin silaj karakterlerini belirlemek amacıyla yürütülmüştür. 10 adet tritikale genotipi (6 adet çeşit, 4 adet ileri hat) materyal olarak kullanılmıştır. Deneme Bingöl koşullarında yürütülmüştür. Silaj yapımı için hasat, hamur olum döneminde yapılmış, silaj örnekleri 5 kg'lık plastik kavanozlara alınmış, analiz için kavanozlar 60 gün sonra açılmıştır. Analiz sonucunda, tritikale genotiplerine bağlı olarak silajda, kuru madde oranının %35.54 ile %41.6 arasında, protein içeriğinin %7.34 ile %10.25 arasında, ham kül oranının %5.21 ile %7.19, NDF oranının %51.24 ile %60.00 arasında, ADF oranının %33.93 ile %39.47 arasında, kuru maddede laktik asit içeriğinin 48.12 ile 59.25 g kg^{-1} arasında, kuru maddede asetik asit içeriğinin 15.41 ile 19.22 g kg^{-1} arasında, kuru maddede propionic asit içeriğinin 2.86 ile 4.21 g kg^{-1} arasında, pH değerlerinin 4.55ile 4.93 arasında, fleig puanlarının 78.74 ile 99.48 arasında, sindirilebilir kuru madde oranının %57.42 ile %62.21 arasında, kuru madde tüketim oranının ise %1.99 ile %2.30 arasında değiştiği belirlenmiştir. Elde edilen sonuçlara göre denemede kullanılan tritikale genotiplerinden elde edilen silajın hayvan beslenmesinde kullanılabilecek silaj kalite kriterlerini taşıdığı belirlenmiştir.

Anahtar Kelimeler: Tritikale, silaj, nispi yem değeri, uçucu yağ asitleri, NDF

Introduction

It is only possible at certain periods of the year to meet the green forage needs of animals from the native roughage resources due to specific vegetation period of each region. This period is about 160-180 days for Central European countries and around 200 days for countries in Mediterranean climate zone (Kutlu, 2010). Therefore, various other sources are utilized to meet the forage needs of the animals during the

rest of the year. The forage, rich in sap, should be supplied to animals at sufficient amounts during the rest of year to minimize the yield differences among seasons (Sakal, 1973; Kılıç, 1986; Özen et al., 1993).

Corn is the most common silage crop due to its high and easily digestible carbohydrate content and proper buffer capacity in addition to high herbage yield. However, growing of corn is a difficult process in regions with short vegetation periods and without irrigation opportunities. Silage of small-grain cereals (barley, triticale, wheat, oat), when prepared accordingly, may also be supplied to dairy cows to meet the dry matter needs of the animals. Such silage crops may be an alternative silage source in cold and dry regions and may provide support to meet silage needs by plating ahead of corn (Crovetto et al., 1998).

Triticale has at least 20% higher hay yield than wheat and also higher forage quality than wheat and rye (Koch and Paisley, 2002; Mut et al., 2006). It is a great source for animal feeding because of its high protein yield and amino acid balance.

Objective of this research was to determine the silage characteristics and nutritional values of different triticale cultivars and lines.

Materials and Methods

This research was carried out during 2009-2010 vegetation period under Bingol conditions. Experimental site has a smooth topography with clay-loam soil texture. Soils of the site have a pH of 7.10, lime content of 0.72%, available phosphorus of 18.07 kg da^{-1} and organic matter of 2.11%. Summers are cool and humid, winters are cold and snowy in experimental site covering the Province of Bingol. Long-term average precipitation is 951 mm, average temperature is 10.2 °C. The experimental season of 2009-2010 was warmer and rainier than long-term averages. In this research, Triticale cultivars of Ümran Hanım, Karma-2000, Tatlıcak-97, Melez-2001, Presto and Mikham-2002 and triticale lines of TBVD-4, TBVD-5, TBVD-8 and TBVD-11 were used as the plant material. Experiments were carried out in randomized block design with 3 replications. Plot width was taken as 5 m. Sowing was performed on 20 October 2009, and 15 kg da^{-1} DAP was applied as substrate fertilizer and 15 kg da^{-1} 33% ammonium nitrate was applied at surface fertilizer. Triticale genotypes were harvested at dough stage, ensiled into 5 kg plastic jars. Jars were opened after 60 days and pH of the silage was measured.

Plant samples were ground in a grinder with 1 mm sieve and prepared for analysis. Dry matter contents of forages (DM) were determined by drying the samples at 70 ^{o}C for 48 hours in an oven, raw ash contents were determined by burning the samples at 550 ^{o}C for 8 hours in an ash oven. Kjeldahl method was used to determine the nitrogen (N) content of silage samples. Crude protein was calculated by using the equation of Nx6.25 (AOAC, 1990). NDF content of the silage was determined by the method defined by Van Soest and Wine (1967), and ADF content was determined according to the method explained by Van Soest (1963). Fleig score was calculated by using the equation of 220+(2×DM%-15)-(40×pH) (Kılıç, 1984). Acetic and propionic acid contents of silage samples were determined by using a gas chromatography (Agilent Technologies 6890N gas chromatography, Stabilwax-DA, 30 m, 0.25 mm ID, 0.25 um df. Max. temp: 260°C. Cat. 11023); lactic acid analyses were performed in accordance with Barker and Summerson (1941). Digestible dry matter, dry matter intake and relative feed value were calculated by using the following equations (Rohweder, 1978):

Digestible dry matter (DDM%) = 88.9 - (0.779 X ADF%)

Dry matter intake (DMI%) = 120 / NDF%

Relative feed value (RFV) = (DDM% X DMI%) / 1.29

Variance analysis on experimental findings was performed by using SAS (SAS Inst., 1999) software and Duncan test was used to test the significance of differences among means. Biplot analysis was performed for better representation and evaluation of results. The parameters with positive relationships were clustered in the same region and the parameters with negative relationships were clustered in different regions

Results

Chemical compositions of triticale silages were presented in Table 1. Dry matter contents of silage samples varied between 35.54% and 41.46%. While the highest value was determined in cultivar Karma-2000, it was followed by genotype TBVD-5. Highly significant differences were determined among triticale genotypes with regard to crude protein ratios. Crude protein ratios ranged between 7.34% and 10.25%. While the highest value was obtained from genotype TBVD-4, the genotypes Tatlıcak-97 and TBVD-11 showed the crude protein ratios being not statistically different from that of genotype TBVD-4. The lowest value was determined in cultivar Mikham-2002 and genotypes Melez-2001, Presto, Karma-2000 and TBVD-8 were also placed in the same group. With regard to ash content, the highest value (7.19%) was obtained from cultivar Melez-2001 and the lowest (5.21%) from genotype TBVD-5. Significant

differences were determined among the genotypes NDF and ADF contents which are digestibility indicators of silage. Depending on the genotypes, NDF ratios varied between 51.24% and 60.00% and ADF ratios between 33.93% and 39.47%. While the lowest values with regard to both characteristics were obtained from cultivar Karma-2000, the highest values were determined in genotypes TBVD-8 and Melez-2001.

Table 1. Chemical compositions of silages from different triticale genotypes

Genotypes	Chemical compositions (%)				
	DM	CP	Ash	NDF	ADF
Mikham-2002	39.38 c[+]	7.34 d	6.11 dc	56.60 cd	36.22 b
Melez-2001	36.06 e	7.61 cd	7.19 a	60.00 a	39.41 a
Presto	39.04 cd	7.84 cd	5.85 d	56.27 cd	36.63 b
Ümran Hanım	38.25 d	7.95 bc	5.71 ef	58.76 ab	36.17 b
Tatlıcak-97	36.03 e	10.20 a	6.54 b	57.53 bc	37.04 b
Karma-2000	41.46 a	7.56 cd	5.59 ef	51.24 e	33.93 c
TBVD-4	39.97 bc	10.25 a	5.53 f	56.80 cd	38.65 a
TBVD-5	40.64 ab	8.37 b	5.21 g	55.93 d	35.83 b
TBVD-8	35.54 e	7.55 cd	5.64 ef	59.93 a	39.47 a
TBVD-11	39.23 c	10.20 a	6.23 c	55.53 d	36.01 b
LS	**	**	**	**	**

[+]DM: Dry Matter, CP: Crude Protein, NDF: Neutral Detergent Fiber, ADF: Acid Detergent Fiber; LS: Level of Significance; ** P<0.01;[+] Means with the same letter in a column are not statistically significant different from each other according to the Duncan test at P≤0.01

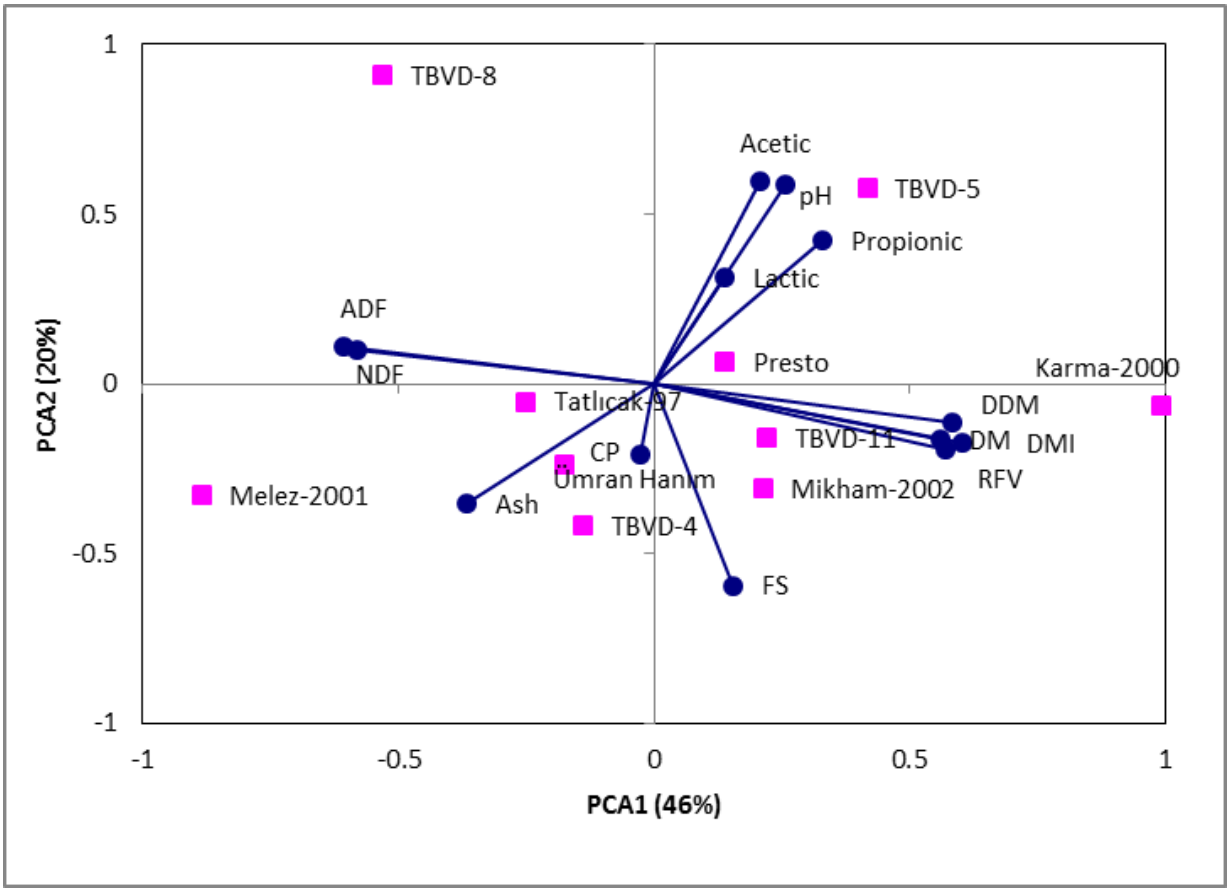
Fermentation characteristics and Fleig scores of triticale silages were presented in Table 2. Depending on the genotypes, lactic acid content of the silage varied between 48.12 and 59.25 g kg^{-1} DM. While the lowest value was determined in silage from cultivar Tatlıcak-97, the highest value was determined in that from the line TBVD-5. Acidic acid contents ranged between 15.41 and 19.22 g kg^{-1} DM. As it was in lactic acid, the highest value was obtained from the line TBVD-5 line and the lowest from the cultivar Ümran Hanım. Propionic acid contents varied between 2.86 and 4.21 g kg^{-1} DM with the lowest value in the silage of the cultivar Ümran Hanım and the highest in that of cultivar Presto. pH of silage samples ranged between 4.55 and 4.93 with the highest value in the silage of the line TBVD-8 and the lowest one in that of the cultivar Melz-2001. With regard to Fleig scores, silages from almost all of the triticale genotypes were placed into high-quality silage group. Only the silage from the line TBVD-8 with a score of 78.74 had lower value than the others.

Digestible dry matter, dry matter intake and the relative feed values of triticale silages were given in Table 3. Digestible dry matter concentrations of silages varied between 57.42% and 62.21%. The highest value was calculated for the silage from the cultivar Karma-2000.

Table 2. Fermentation characteristics and Fleig scores of silages from different triticale genotypes

Genotypes	Parameters				
	Lactic	Acetic	Propionic	pH	FS
Mikham-2002	54.51 d[+]	16.26 f	4.05 c	4.63 de	98.43 a
Melez-2001	54.90 c	16.22 f	2.90 h	4.55 e	95.13 bc
Presto	58.48 b	17.23 e	4.21 a	4.68 cd	95.75 b
Ümranhanım	54.17 e	15.41 g	2.86 ı	4.72 cd	92.57 cd
Tatlıcak-97	48.12 ı	17.67 d	3.21 g	4.79 b	85.47 f
Karma-2000	53.77 f	18.57 c	3.64 e	4.85 ab	93.91 bc
TBVD-4	50.52 h	17.23 e	2.90 h	4.64 de	99.48 a
TBVD-5	59.25 a	19.22 a	4.12 b	4.90 ab	90.42 de
TBVD-8	54.22 g	18.88 b	3.78 d	4.93 a	78.74 g
TBVD-11	52.25 g	16.25 f	3.56 f	4.87 ab	88.53 e
LS	**	**	**	**	**

FS: Fleig score; LS: Level of Significance; ** P<0.01; [+] Means with the same letter in a column are not statistically significant different from each other according to the Duncan test at P≤0.01



CP: Crude Protein, CA: Crude Ash, DM: Dry Matter, ADF: Acid Detergent Fiber; NDF: Neutral Detergent Fiber, DDM: Digestibility Dry Matter, DMI: Dry Matter Intake, RFV: Relative Feed Value, LA: Lactic Acid, AA: Acetic Acid, Propionic Acid, FS: Fleig score

Figure 1. The biplot of 10 triticale genotypes for silage quality and nutritive value

The cultivars Mikham-2002 and Ümran Hanım as well as the line TBVD-5 showed the digestible dry matter concentration values being not significantly different from the cultivar Karma-2000. The lowest value was calculated for the silage from the cultivar Melez-2001. Dry matter intake values ranges between 1.99% and 2.30% with the highest value for the silage from the cultivar Karma-2000 and the lowest value in those from the cultivar Melez-2001 and the line TBVD-8. Relative feed values varied between 88.55 and 110.90. While the highest value was obtained from the cultivar Karma-2000, the lowest one was obtained from the cultivar Melez-2001.

Figure 1 revealed that while the genotypes TBVD-4, Melez-2001 and Ümran Hanım were characterized by their crude ash and crude protein ratios,Tatlıcak-97 and TBVD-8 with their NDF and ADF ratios, the genotypes Mikham-2002, Presto, Karma-2000 and TBVD-11 with their DMI, DM, RFV, Fleig scores, and the line TBVD-5 with silage acids and pH characteristics.

Table 3. Digestible dry matter, dry matter intake and the relative feed value of silages from different triticale genotypes

Genotypes	Parameters		
	DDM %	DMI %	RFV
Mikham-2002	60.68 ab^{+}	2.16 bc	101.63 bc
Melez-2001	57.42 d	1.99 d	88.55 e
Presto	59.84 bc	2.11 bcd	97.79 cd
Ümranhanım	60.47ab	2.03 d	95.34 d
Tatlıcak-97	60.04 bc	2.09 cd	97.10 d
Karma-2000	62.21 a	2.30 a	110.90 a
TBVD-4	59.31 bcd	2.09 cd	96.04 d
TBVD-5	60.46 ab	2.10 bcd	98.31 cd
TBVD-8	58.16 cd	1.99 d	89.78 e
TBVD-11	59.81 bc	2.22 ab	102.70 b
LS	**	**	**

DDM: Digestibility Dry Matter (%); DMI: Dry Matter Intake (%); RFV: Relative Feed Value; LS: Level of Significance; ** P<0.01;$^{+}$ Means with the same letter in a column are not statistically significant different from each other according to the Duncan test at P≤0.01

Discussion

Ball et al. (2001) indicated that dry matter and protein ratios of plants might differ based on plant genetic structure, leaf, ear and stem ratios, ripening periods, temperature and fertilization. Findings of current study were similar to findings of Lekgari et al. (2008), Nadeau (2007), Zobell et al. (1992), McCartney and Vaage (1994). Although Kara et al. (2009) used some of the same plant material of current study; they observed different dry matter and protein ratios. The reason for such differences may be differences between the experiments in soil and climate characteristics as well as cultural practices. While the ash values of present study were closer to findings of Nadeau (2007) for some cultivars, the values were lower than those observed by Kara et al. (2009).

Increasing acetic acid content of the silage decrease energy level and increase dry matter loss. Recommended DM content for high quality silage is 3-4% (Edward, 1993). Higher pH values were determined in current study than the values found by McCartney and Vagge, 1994. Increasing dry matter content and decreasing soluble sugar content with progression of ripening cause to high pH value and decrease lactic acid and acetic acid values (Kung and Shaver, 2001). pH values for silages in the present study were closer to those observed by Kara et al. (2009) and Ozduven et al. (2010), and organic acid contents were similar to findings of Nadeau (2007). Determination of water-soluble carbohydrate ratios and ammonia contents may help in achieving more reliable results.

Low ADF and NDF contents are usually desired for forage crops since these materials complicate digestion and consequently decrease the quality. ADF and NDF contents determined in the silages of current study were similar to findings of several researchers. ADF contents were similar to findings of Nadeau (2007), Zobell et al. (1992), McCartney and Vaage (1994), Edward (1993), and NDF contents were similar to the values determined by Rodrigo et al. (2010), McCartney and Vaage (1994), Edward (1993), Lekgari et al. (2008).

Digestible dry matter findings are similar with the findings of Ozduven et al. (2010). Dry matter intake values of current study were lower than those determined by Zobell et al., 1992. Relative feed values were similar to values obtained by Sürmen et al. (2011) and Lekgari et al. (2008). With regard to relative feed value, triticale silages of current study were classified as 4th level according to Hay Market Task Force of American Forage and Grassland Council.

Conclusion

While the genotypes Umran Hanım, Melez-2001 and TBVD-4 were characterized with their crude protein and ash contents, the genotypes Mikham-2002, Presto, TBVD-11 and Karma-2000 were characterized with DMI, RFV, Fleig score and DDM, and the genotypes Tatlıcak-97 and TBVD-8 with ADF and NDF. Essential oil acids and pH were the main characteristics to be used to define the line TBVD-5.

Triticale genotypes were found to be suitable as an alternative silage crop with regard to both their chemical compositions and silage characteristics. Growing of high-yielding cultivars by taking regional soil and climate characteristics into consideration may provide a high-quality forage source for livestock.

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