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Research Article

The Effect of Barley Paste, Barley Straw and Wheat Bran Addition to Sugar Beet Leaves Silages on Feed Value, Silage Quality and In Vitro Organic Matter Digestibility

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Abstract

This study has been carried out to investigate the effects of adding barley paste, barley straw, and wheat bran to sugar beet leaves (SBL) silages on the nutrient content, silage quality and in vitro organic matter digestibility of the silages. Following the sugar beet harvest, 10% barley paste (BP), 10% barley straw (BS), and 10% wheat bran (WB) were added to the sugar beet leaves taken after the sugar beet harvest, and then they were ensiled in 1 liter special glass jars and four application groups were formed as being control, SBL+BP, SBL+BS, and SBL+WB. Analyzes were carried out in three replications for each silage group. According to the study findings, for the control, SBL+BP, SBL+BS and SBL+WB groups respectively, dry matter at percentages of 18.65%, 23.35%, 21.40%, 21.02%, pH at levels of 4.01, 3.89, 3.94, 3.91, and crude protein at percentages of 11.24%, 12.06%, 7.83%, 11.32% were found. At the end of the study, it was determined that the addition of 10% barley paste to the sugar beet leaves increased the silage dry matter content and fleig score.

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Key words: Sugar beet leaves, feed value, silage additive, OM digestibility

Şeker Pancarı Yaprağı Silajına Arpa Ezmesi, Arpa Samanı ve Buğday Kepeği İlavesinin Yem Değeri, Silaj Kalitesi ve İn Vitro Organik Madde Sindirilebilirliği Üzerine Etkisi

Öz

Bu çalışma, şeker pancarı yaprağı (ŞPY) silajlarına arpa ezmesi, arpa samanı ve buğday kepeği ilavesinin silajların besin madde içeriği, silaj kalitesi ve in vitro organik madde sindirilebilirliğine olan etkisini araştırmak üzere yapılmıştır. Şeker pancarı hasadı sonrası alınan şeker pancarı yapraklarına %10 arpa ezmesi (AE), %10 arpa samanı (AS), ve %10 buğday kepeği (BK) ilave edilerek, 1 litrelik özel cam kavanozlarda silolanarak kontrol, ŞPY+AE, ŞPY+AS ve ŞPY+BK olmak üzere dört uygulama grubu oluşturulmuştur. Analizler her bir silaj grubunda üç tekerrür olarak yürütülmüştür. Çalışma bulgularına göre; kontrol, ŞPY+AE, ŞPY+AS ve ŞPY+BK silaj gruplarının kuru madde %18.65, % 23.35, %21.40, %21.02, pH 4.01, 3.89, 3.94, 3.91 ve ham protein içerikleri %11.24, %12.06, %7.83, %11.32 olarak saptanmıştır. Araştırmanın sonunda şeker pancarı yaprağına %10 arpa ezme ilavesinin silaj kuru madde içeriğini ve fleig puanını arttırdığı saptanmıştır.

Anahtar kelimeler: Şeker pancarı yaprağı, besin değeri, silaj katkı maddesi, OM sindirilebilirliği

Introduction

Sugar beet is an important leaves source throughout the world and it is one of the ten most produced products in many countries such as Chile, Belgium, Germany, France, Netherlands, Italy, Turkey, and Russia (FAOSTAT 2014). 8.582.038 tons of beet production was realized in Turkey in year 2020 (Türkşeker 2021). Sugar beet leaves and head are obtained up to 80%-85% of the root yield of sugar beet per decare. 80% of the heads and leaves obtained after the sugar beet harvest are left in the field and only 2% of these are fed to animals (Pimlott 1991). There is a shortage of roughage, which has an important place in the nutrition of ruminant animals in Turkey. The sugar beet leaves, being rich in protein and sugar content, which is loved and consumed by animals, cannot be sufficiently utilized. It is more economical and advantageous to make silage of sugar beet leaves instead of leaving them as organic fertilizer in the field (Kılıç 1986; Przybl 1994). Sugar beet leaves silage is loved and consumed by lactating dairy cows, and as a result, roughage consumption increases (Brabender et al., 1983). Straw, wheat bran, dried sugar beet pulp and grains are added to sugar beet leaves silages in order to increase the low dry matter level and to prevent losses caused by silo water (Corporaal 1987; Keady 2000). This study was realized to determine the nutrient content, in vitro organic matter digestibility (OMD) and metabolic energy (ME) contents of silages prepared by adding barley paste, barley straw, and wheat bran to sugar beet leaves.

Materials and Methods

The feed material of the study of was taken from the producers in Van province at harvesting time of sugar beet (*Beta Vulgaris L.* Kassandra) (16 September). Van province located between 42° 40' and 44° 30' east longitudes and 37° 43' and 39° 26' north latitudes in Turkey. The annual mean temprature is 8.9°. Silage treatments were divided into four groups after the sugar beet leaves was cut into 1.0-1.5 cm lengths: control, 10% barley paste, 10% barley straw and 10% wheat bran. Sugar beet leaves was combined with the additive and ensiled in 40 pieces of 1-liter laboratory type glass containers (Weck, Wher-Oftlingen and; Germany) fitted with gas-release-only lids. For a period of 60 days, the silage samples were stored at room temperature (20±1ºC). On the 60th day, samples were taken from three glass jars per treatment from all group for the analyses of the chemical, in vitro digestibility organic matter, metabolizable energy and cell wall contents.

Analytical procedure

Three samples were taken from all silage groups for chemical analyzes. The fresh sugar beet leaves and treatment samples were dried at 60 ºC for 72 hours, and then the dried samples were ground and passed through a 1 mm sieve for analysis. After drying at 105 °C for 4 hours , the amount of dry matter (DM) content of silages, specifically the CP (crude protein) and ash contents of the silage groups were found according to the analysis methods described by AOAC (1990) methods. Sugar contents of samples were determined according to the methods of TSE (1991). The following values were also calculated: dry matter (DM) digestibility, dry matter intake (DMI). pH values fresh and silage samples were determined according to Anonymous (1986). Neutral detergent fiber (NDF) and acid detergent fiber (ADF), acid detergen lignin content of sugar beet leaves silages were found using the method described by Van Soest et al., (1991). Relative feed value was determined by calculation (Van Dyke and Anderson 2000). Fleig points of silages were calculated as specified by Kılıç (1984). The metabolizable energy contents of the study were calculated as specified in TSE 1991. In vitro OMD contents of silages were determined according to the enzyme method reported by Naumann and Bassler (1993). For this purpose, pepsin enzyme (Merck, 0.7 FIP-U/g, Germany) and cellulase enzyme obtained from Trichoderma viride microorganisms (Merck, Onozuka R10; Germany) were used.

Statistical Analysis

Statistical analyses were performed with the general linear model (GLM) procedure of Duncan's multiple range test performed with the Statistical Analysis System (2005) Software (SAS, Cary, N.C.).

$Yij = \mu + ai + ei,$

Yij = investigated properties

μ = mean

ai = effect of the treatment

eij = effect of random.

The probability level of P<0.05 considered significant. When significant relationships were distinguished, the average values for each effect were compared using the Duncan test.

Results and Discussion

Chemical composition of the sugar beet leaves silages are given in Table 1. According to the findings of the chemical composition obtained from the study, the high DM content was found in the23.35% SBL+BP treatment and followed by 21.40% SBL+BS, 21.02% SBL+WB, 18.65% control groups and differences were found statistically significant (P<0.01). The reason for the increase in SBL silages dry matter content is that dry matter contents of BP, BS, WB higher than SBL. Study findings of DM contents were higher than found by Kılıç (1984), Can et al., (2003). Alhan and Can (2017), Gerlach et al., (2017) and lower than found by Gurbuz and Kaplan (2008). The finding DM contents of SBL silage groups are consistent with findings of Hellwing et al., (2017). BP, BS, WB used as additive improve the fermentation and prevent DM loses. The differences between the DM findings of the study and the previous studies findings is due to the plant composition, soil structure and different additives used.

In the study OM contents of silage groups ranged between 55.52%-77.19% respectively (P<0.01). Addition BP and WB to the silage increased the OM content of silage compared with control group. High OM content in SBL+BP and SBL+WB silages is due to the higher organic matter content of BP and WB than SBL. OM findings of the study were found to be lower than the findings of Ak et al., (2000) and Can et al., (2003). The differences between OM findings of the study and literature findings is due to plant composition, soil structure and different additives used.

Protein contents of SBL silages were found to be as 12.06% in SBL+BP, 11.32% in SBL+WB, 11.24% in the control, and 7.83% in SBL+BS, respectively. The differences between the treatment groups came out to be significant (P<0.01). The reason for the higher protein content of SBL+BP and SBL+WB silages compared to the control group is the high protein content of BP and WB. While CP contents of the study are found to be lower than findings in reports of Ak et al., (2000), Alhan and Can (2017), Sun and Wang (2013), Suliman et al., (2013), they were found to be higher than the findings in reports of Gurbuz and Kaplan (2008) and Hellwing et al., (2017). Van Soest (1994) and NRC (2000) reported that most of conserved cereals have contain protein at 60-100 g/kgDM. This shows that SBL silages meet the protein requirement of ruminant animals.

Ash content of SBL silages varies between 17.91%-36.86%. The ash content of the BP added silage was found to be significantly lower. The ash content of the SBL+WB and control groups was similar, the ash content of the SBL+BS silage was found to be higher than the other groups, and the differences were statistically significant (P<0.01). While the ash contents of the study were higher than the findings of Can et al., (2003), Alhan and Can (2017), they showed similarity with findings of Hellwing et al., (2017) and Suliman et al., (2013). The ash content of SBL+BP silage was found to be the same as the report of Gurbuz and Kaplan (2008). The differences between the studies are due to the soil structure, additives and whether the leaves are contaminated with the soil.

BP, BS, and WB added to the silages caused a significant decrease in the pH of the silages (P<0.05). The lowest pH levels were found to be 3.89 in SBL+BP, 3.91 in SBL+WB, and 3.94 in SBL +BS, respectively. For a good quality silage, a good fermentation environment and a rapid reduction of pH are required (Van Soest 1994). The pH values of the study were found to be the same as the optimum silage pH values of 3.8-4.2. While pH findings showed similarities with findings in reports of Alhan and Can (2017), Gerlach et al., (2017), Hellwing et al., (2017), they were found to be lower than findings in reports of Can et al., (2003), Gurbuz and Kaplan (2008), and Undiandeye et al., (2022). Differences pH contents between studies may have been results of additives was used.

The highest sugar contents of SBL silages were determined in 7.70% in control, 7.30% in SBL+WB, 7.00% in SBL BS and 4.60% in SBL+BP groups, respectively, and the differences were significant (P<0.01). The addition of WB and BS to the silages ensured the preservation of the sugar content of the silage. It has been reported that more than 20% of sugar is converted into ethanol as a result of the activity of yeasts in the additive-free SBL silages (Thaysen et al., 2012; Gerlach et al., 2017). In this study, the sugar content was preserved in all silages except SBL+BP. The sugar content of silages was lower than the report of Thaysen et al., (2012), but higher than the report of Gerlach et al., (2017). The differences between sugar contents of study and previous report findings is due to plant chemical content, soil structure and used BP, BS, WB as additive.

The highest ether extract (EE) contents of silages were found in 1.81% in SBL+WB, 1.78% in SBL+BP, 1.55% in control and 1.15% in SBL+BS groups, respectively (P<0.01). The reason why SBL+WB and SBL+BP contain more ether extract than the control group is because the amount of ether extract contained in WB and BP is higher than SBL. While EE contents of silages were found higher than the findings of Gerlach et al., (2017), they were found to be lower than the findings of Ak (2000).

Table 1. Chemical compositions of the sugar beet leaves silages (% DM)

Treatments	DM %	OM %	CP %	Ash %	pH	Sugar %	EE %
Control	18.65d**	57.82c**	11.24b**	33.86b**	4.01a*	7.70a**	1.55b**
SBL+BP	23.35a**	77.19a**	12.06a**	17.91c**	3.89b*	4.60b**	1.78a**
SBL+BS	21.40b**	55.52d**	7.83c**	36.86a**	3.94ab*	7 00a**	1.15c**
SBL+WB	21.02c**	64.18b**	11.32b**	33.86b**	3.91b*	7.30a**	1.81a**
SEM	0.50	2.54	0.49	2.24	0.01	0.38	0.08
P	0.000	0.000	0.000	0.000	0.005	0.000	0.000

*(P<0,05), ** (P<0,01) DM: dry matter, OM: organic matter, CP: crude protein, EE: ether extracts, SBL: sugar beat leavees BP: barley paste, BS: barley straw, WB: wheat bran

Fleig points and cell wall contents of the sugar beet leaves are given Table 2. Addition of BP, BS and WB to SBL silages increased the Fleig score and value of the silages (P<0.01). The Fleig score of the SBL+BP group was found to be very high (96.06), followed by 90.64 in SBL+WB, 90.21in SBL+BS and 81.00 in control groups, respectively. Fleig score values of the study were found to be higher than findings in reports of Can et al., (2003) and Alhan and Can (2017). The differences between the statements are due to the practices in making the silage and the additives used.

ADF, NDF, ADL values of SBL silages were determined as 12.93%-15.31%, 24.91%-27.78% and 5.74%-10.05% for control, SBL+BP, SBL+BS and SBL+WB groups, respectively and the differences between the treatments were statistically significant (P<0.01). Addition of BP to the silage reduced the ADF content of silage compared to the control group. While the addition of WB to the silage provided a lesser decrease compared to the control group, the ADF content of SBL+BS silage also increased due to the higher ADF content of BS. While the ADF content of the control group was similar to the reports of Alhan and Can (2017), the ADF contents of the SBL+BS, SBL+BP, SBL+WB silage groups were found to be low. ADF contents of the silage groups belonging to the study were found to be lower than the reports of Can et al., (2003) and Gurbuz and Kaplan (2008). When compared with the control group, it was determined that the additions of BP, BS and WB to the silages caused similar increases in the NDF content of the silages. NDF contents of silages were found to be lower than the reports of Alhan and Can (2017) and Gurbuz and Kaplan (2008) and higher than the reports of Hellwing et al., (2017). It was determined that there was an increase in ADL contents of SBL+BP and SBL+WB silages compared to the control group, and a decrease in SBL+BS silage. The ADL findings of the study were higher than the findings of Gerlach et al., (2017). The differences for the ADF, NDF, ADL, contents of SBL silages are stem from plant, pasture management, soil structure and additives.

Table 2. Fleig points and cell wall contents of the sugar beet leaves silages (% DM)

Treatments	FP	ADF%	NDF%	ADL%
Control	81.00c**	14.29b**	24.91c**	6.06c**
SBL+BP	96.06a**	12.93c**	27.07b**	7.90b**
SBL+BS	90.21b**	15.31a**	27.78a**	5.74c**
SBL+WB	90.64b**	14.00b**	27.32ab**	10.05a**
SEM	1.76	0.29	0.34	0.52
P	0.000	0.000	0.000	0.000

**(P<0.01) FP: fleig points, NDF: nötral detergan fiber, ADF: acid detergen fiber, ADL: acid detergen lignin, SBL: sugar beat leavees, BP: barley paste, BS: barley straw, WB: wheat bran

Determine the forage quality is to feed the forage directly to animals. It's hard and not economic. For this reason the relative feed value (RFV) identified in the United State of America for alfalfa and forages (Goktepe and Selcuk 2017). In this study high RFV value was found in control group (277.75). The SBL+BP (259.61), SBL+WB (253.09) and SBL+BS (246.10) groups (Table 3). RFV contents of treatment groups lower than compare with the control group.

SBL+BP silage has positive effect on digestible dry matter (DDM) (78.05%) and found higher than control group (77.66%) (Table 3). SBL+WB silage has similar with control group. SBL+BS silage has lower effect on DDM and found lower than the other groups. Control group finding of DDM was found lower than findings of Alhan and Can (2017). DDM findings of other groups (SBL+WB, SBL+BS, SBL+BP) were higher than findings of Can et al., (2003), Suliman et al., (2013) and Alhan and Can (2017).

Higher DMI values of SBL silages were found in the control group (4.86%). SBL+BP and SBL+WB silages contain same (14.49%). DMI value (P<0.01). DMI contents of silages were found to be higher than the findings of Gurbuz and Kaplan (2008), Gerlach et al., (2017), and Suliman et al., (2013). Differences between studies stem from, different additives, harvest season and silage process.

Table 3. Digestible dry matter (% DM), dry matter intake (% DM) and relative feed value contents of the sugar beet leaves silages

Treatments	RFV	DDM %	DMI %
Control	277.75a**	77.66a**	4.86a*
SBL+BP	259.61b**	78.05a**	4.49ab*
SBL+BS	246.10c**	76.61b**	4.33b*
SBL+WB	253.09b**	77.98a**	4.49ab*
SEM	3.65	0.18	0.07
P	0.000	0.000	0.005

*(P<0,05), ** (P<0,01) RFV: relative feed value, DDM: digestible dry matter, DMI: dry matter intake, SBL: sugar beet leavees, BP: barley paste, BS: barley straw, WB: wheat bran

OMD and ME contents of SBL silages were ranged between 61.45%-80.57% and 4.92-8.85 MJ/kg DM relatively (Table 4). Differences were found significiant (P<0.01). OMD contents of SBL+BP (74.45%), SBL+BS (71.48%) and SBL+WB (61.45%) were lower than control group (80.57%). While the ME contents of the control group was higher than the reports of Gurbuz and Kaplan (2008), the ME contents of the SBL+WB, SBL+BS, and SBL+BP groups were found to be lower. The differences between the declarations are due to the differences in chemical composition, additives, and the method which is used.

Table 4. In vitro OMD (% DM) and ME (MJ/kg) contents of of the sugar beet leaves silages

Treatments	OMD %	ME MJ/kg DM
Control	80.57a**	7.08b**
SBL+BP	74.45b**	8.85c**
SBL+BS	71.48b**	5.60c**
SBL+WB	61.45c**	4.92d**
SEM	1.14	0.10
P	0.000	0.000

** (P<0.01). OMD: organic matter digestibility, ME: metabolizable energy, SBL: sugar beat leaves BF:barley paste, BS: barley straw, WB: wheat bran

Conclusion

At the end of the study, it was determined that the addition of barley paste to sugar beet leaves silages increased the content of silage, protein, and ME. It was determined that sugar beet leaves silage is a good feed source in the nutrition of dairy cows, but that feeding trials are required to determine the performance of silages on animals.

Conflict of Interest Declaration: There is no conflict of interest.

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