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RESEARCH PAPER

Determination of the Effects of Grape Pomace Addition to Sorghum Sudan Grass on Silage Quality

Recep BULUT [1], Mehmet Akif KARSLI [2,*], Hasan Hüseyin ŞENYÜZ [3]

[1] Kırıkkale Directorate of Provincial Agriculture and Forestry, Kırıkkale, Türkiye
[2] Kırıkkale University, Faculty of Veterinary Medicine, Department of Animal Nutrition and Nutritional Disease, Kırıkkale, Türkiye
[3] Necmettin Erbakan University, Faculty of Veterinary Medicine, Department of Animal Nutrition and Nutritional Disease, Ereğli, Konya, Türkiye
*Corresponding Author

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Corresponding Author*
e-mail:mehmetakifkarsli@hotmail.com

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Abstract

The aim of this study was to determine the silage quality and *in situ* degradability of silages prepared with addition of grape pomace into variety of sorghum-sudan grass as rapid fermentable carbohydrate source. Grape pomace obtained at the region was ensiled with sorghum- sudan grass grown at Keskin Fodder Plants Production and Processing Facility at same period at the levels of 0, 10, 20 and 40%. Glass jars (1L) were used for ensiling of silages. Four silage samples were prepared for each treatment groups. After 45 days of ensiling, silage samples were opened and pH, organic acid, nutrient contents, and *in situ* degradation levels were determined. Among silage fermentation parameters, pH and volatile fatty acid concentrations did not differ among silage prepared from different sorghum-sudan grass varieties (P>0.05), grape pomace significantly increased the pH of sorghum-sudan grass silages and decreased lactic acid concentrations of sorghum-sudan grass silages (P<0.05). Nutrient contents, except CP content, significantly differed between sorghum-sudan grass varieties, addition of grape pomace into sorghum-sudan grass significantly alter the nutrient contents of silages (P<0.05). While in situ OM, NDF and ADF degradabilities were similar between sorghum-sudan grass varieties, addition of grape pomace significantly decreased OM degradability in both sorghum-sudan grass varieties (P<0.05). In conclusion, addition of grape pomace into sorghum-sudan grass up to 40% had some negative effects on silage quality, but it was taught that grape pomace can be utilized as alternatve feedstuffs for ruminants by adding sorghum-sudan grass up to 20%.

Introduction

One of the biggest problems of the livestock sector is insufficient production of roughage, in terms of both quantity and quality, which should be included in the rations of ruminant animals (Bingöl *et al.*,2010). In order to minimize the quality roughage needs for livestock enterprises, forage crop production areas should be increased, meadow and pasture qualities should be improved, especially cheap and alternative roughage sources (pulp) should be brought into animal production and quality roughage production techniques should be transferred to breeders. If abondant and cheap high quality orage is avalable, then, an economical animal breeding can be possible (Alçiçek *et al*., 2010). It has been accepted by the world as a result of researches the importance of roughage, especially in dairy cattle. Many wet by-products are ensiled and the animals are constantly fed with fresh feed over a whole year (Faostat, 2011).

Increasing the human population in the world increases the need for animal products. The increase in the number of animals and the inadequacy of forage crops production have led scientists to alternative roughage. In Turkey 3.650.000 tons of grapes are produced annually, and 423,527 tons of this has been utilized for wine production (TÜİK, 2015). This wine type grape yields 105,882 tons of pomace per year. This figure corresponds to 25% of the wine type grapes (Kılıç and Abdiwali, 2016).

Since the grape pomace deteriorates rapidly due to its high water content, it should either be consumed in a short time or dried so that the water content decreases to 10% (Özdüven *et al*., 2005). Otherwise, it is not possible to preserve it. It has been reported that the addition of grape pomace in alfalfa silages at the rate of 4% - 20%, increased both silage quality and *in vitro* digestibility, in parallel with the increases in silage (Canbolat *et al*., 2010).

Although the remaining grape pomace, which is generally byproduct of wine and vinegar production, is offered to animal consumption as fresh by livestock enterprises, it is not possible to store it for a long time because of its high water content. Therefore, the effects on quality and *in situ* degradability of silages prepared by adding varying amounts of grape pomace to two different sorghum-sudan grass hybrids grown in Kırıkkale province were evaluated in the study.

In this study, it was aimed to determine the effects of adding at varying rates of grape pomace to two different sorghum-sudan grass hybrids on silage quality, nutrient composition and *in situ* degradability of silages.

Materials and Methods

In this study, the effects on silage quality and *in situ* degradability were tried to be determined by adding varying amounts of grape pomace to two different sorghum-sudan grass hybrids grown in Kırıkkale province. For this purpose, grape pomace samples were collected from plants producing fruit juice, vinegar, molasses and wine in the region during 2014 and 2015 fruit harvest periods. Sorghum-sudan grasses were produced in Keskin Fodder Plants Production and Processing Facility in the same period. It was ensiled by mixing sorghum-sudan grass with 0% (control), 10, 20 and 40% grape pomace. One liter jars were used for ensiling the silages. Each experimental group was prepared as 4 replications. After the jars were tightened as much as possible by hand, their lids were tightly closed and pierced with a nail. The silages prepared in jars were turned upside down and left to mature in a dark and cool room. A few days after the silage water removal, the holes opened with nails were closed with a tape and left to mature. Silages opened after 45 days of maturation and pH, volatile fatty acid, nutrient contents and *in situ* degradability were determined. After the silages were dried first in air and then in an oven, other nutrient analyzes were made.

The pH and volatile fatty acid analyzes of the silages were determined from the filtrates obtained from the silages. For this purpose, after adding 100 ml of distilled water on 25 g of silage sample, this mixture was thoroughly homogenized with the help of a blender. The pH of the silage was determined by measuring with a pH meter (Polan *et al*., 1998). The silage liquid obtained by filtering through filter paper (Whatman) was stored at -18ºC until the organic acid analysis.

Three rumen cannulated Holstein dairy cows were used to determine the *in situ* degradability of the silages. During the experiment, cows were fed twice a day with alfalfa grass and barley straw as roughage and barley and wheat flakes mixture as concentrated feed. During the trial period, the animals were fed with a ration consisting of 60% roughage (50% alfalfa hay and 50% barley straw) and 40% grain feed (50% barley and 50% wheat flakes). Animals were consumed this ration for a total of 16 days, of 14 days of adaptation and 2 days of sample collection. Clean water and vitamin-mineral blocks were kept in front of the animals at all times.

The feed samples incubated were ground to a particle size of 2 mm after drying. The feed samples were weighed 3-4 g in two parallel for each animal and for each hour and put into 10 x 5 cm dacron pouches with a 40 µ pore size. After the mouths of the pouches were tightly tied with rubber bands, they were placed in nylon nets with a size of 40x20 cm, with a pore size of 0.3 cm, in which weight was placed in order to keep them in the ventral part of the rumen.

The nets are placed in the ventral cavity of the rumen of the cows. The prepared nylon bags were left in the rumen for 0, 2, 4, 8, 12, 24 and 48 hours. At the end of each incubation period, the pouches were removed from the rumen and the contaminated feed particles were removed by washing with pressurized cold water to prevent microbial activity. Then, the pouches were washed under running water until the color of the water became clear (approximately 15 minutes) dried in an oven at 65ºC for 24 hours (Çetinkaya, 1992), and their weights were recorded. The dry matter (DM), organic matter (OM) neutral detergent fiber (NDF) and acid detergen fiber (ADF) contents of the remaining feed residues in the pouches were determined and the OM, NDF and ADF degradability were calculated according to the following formula;

nutrient degradability = a +b$^{(1-e-ct)}$ (Orskov 1985).

The DM, crude ash (CA), OM, and crude protein (CP) contents of the feed samples used in the experiment were determined according to the AOAC (1990), NDF according to Van Soest and Robertson (1979), ADF according to Goering. and Van Soest (1970).

In the filtrate obtained from silage samples, organic acids (lactic acid, acetic acid, propionic acid and butyric acid) analyses were run according to the method reported by Leventini *et al*. (1990) at the gas chromatography (Shimadzu GC14B). Ammonia determination was made by the distillation method specified by Filya (2003).

All data obtained in the study were subjected to two-way analysis of variance SAS, (1995). First, the statistical difference between sorghum cultivars was determined and given as P value in the tables. Then, the Duncan-t test was used to determine the differences due to grape pomace use in both sorghum varieties (Steel and Torie, 1980).

Results and Discussion

The nutrient contents of the grape pomace used are given in Table 1. When the table is examined, it is seen that white and black grape pomace have similar nutrient content, but black grape pomace has a little bit higher of crude cellulose (CC), NDF and ADF content while the HP level is slightly lower.

Ensminger *et al*. (1990) reported that the nutritional content of grape pomace; CC (30.9%), EE (8.4%), CP (13.4%), nitrogen free substance (39.0%), OM (91.7%), CA (8.3%), NDF (53.2%), ADF (44.4%) and ADL(35.2%). Kılıç and Abdiwali (2016) determined that CA, EE, CC, NDF, ADF and CP values of dried grape pomace were 8.2%, 4.9%, 19.80%, 49.60%, 38.30% and 12.50%, respectively. The crude protein, ADF, NDF, EE and CC contents were similar to the studies mentioned above, while CA values were lower than the studies. Winkler *et al*. (2015), the CA (6.8-3.3%) reported for the pomace of white and red grape varieties was similar with the current study. The differences in the nutrient content of grapes between the studies are probably due to the grape variety of the pomace is obtained, the different applications, the differences in the stalk and seed ratios of the pulp, and the differences in the foreign matter contents such as dust and soil (Kılıç and Abdiwali, 2016).

Nutrient contents of sorghum-sudan grass silages prepared with grape pomace in different proportions are given in Table 2. It was observed that the DM value of the silages prepared from sorghum-sudan crops varied between 25.83-30.75% and there was a statistical difference between the varieties ($P<0.05$). In this study, it was determined that the DM levels were around the ideal DM levels reported by Ergün *et al.* (2001) for silage. The dry matter levels of the silages were affected by the DM levels of the plant species rather than the grape pomace used. The added grape pomace level caused a decrease in the DM level of the Sugar Graze II (SG II) variety containing only 40% of the silage. The reason for this decrease is not understood.

The OM levels of the silages prepared by adding different levels of grape pomace to sorghum-sudan grass were in the range of 90.41-93.23% and similar between sorghum-sudan grass varieties ($P>0.05$). Çiğdem and Uzun (2006) have reported that CA ratios of sorghum x sudan grass hybrid varieties were in the range of 7.84%-8.64%. Also, Salman and Budak (2015) determined the CA values of sorghum x sudan grass hybrids between 6.42% and 9.53% in a study conducted in Ödemiş and Bayındır districts. CA values of the both studies was similar with that of the current study.

Addition of grape pomace to silages did not significantly affect the OM level of sorghum-sudan grass silages in general ($P>0.05$). The CA content of the grape pomace used in the study was at the level of 6% and it is thought that it does not cause any

Table 1. Nutrient contents of grape pomace used in the study (DM%)

	White Grape Pomace	Black Grape Pomace
Dry matter	31,05	32,07
Crude ash	5,50	6,35
Organic matter	94,50	93,65
Ether extract	6,75	6,25
Crude cellulose	26,59	27,67
Neutral detergent fiber	43,73	45,93
Acid detergent fiber	34,86	37,57
Crude protein	12,42	11,98

Table 2. Nutrient contents of silages obtained in the study.

	Sorghum Sudan Grass SG II				Sorghum Sudan Grass GAR				
	0	10	20	40	0	10	20	40	P
DM,%	28,53±1,23^{1}	28,17±1,82^{1}	29,72±1,08^{1}	25,83±1,62^{2}	32,75±0,23	29,11±1,43	31,76±0,87	31,87±0,48	0.05
CA,DM%	6,99±0,56	6,77±0,51	7,29±0,25	7,10±0,34	7,37±0,54^{b}	7,23±0,65^{b}	7,51±0,71^{b}	9,59±0,86^{a}	0.45
OM,DM%	93,01±0,56	93,23±0,51	92,21±0,25	92,90±0,34	92,63±0,54^{a}	92,77±0,65^{a}	92,49±0,71^{a}	90,41±0,86^{b}	0.45
NDF,DM%	60,94±0,44	58,80±0,41	61,62±0,47	62,86±0,33	49,68±2,02^{b}	55,40±0,80^{a}	56,14±1,07^{a}	55,13±1,40^{a}	0.05
ADF,DM%	28,63±0,15^{4}	30,09±0,06^{34}	34,47±0,9^{2}	42,77±0,55^{1}	21,55±1,26^{c}	27,06±1,71^{b}	27,24±2,65^{b}	33,96±1,32^{a}	0.05
CP,DM%	10,63±0,11^{2}	10,62±0,86^{2}	13,64±0,85^{1}	11,19±0,86^{2}	10,71±0,72	11,13±1,01	12,57±0,77	11,71±0,59	0.65

SG II: Sugar Graze II; GAR: Gardavan; DM: Dry matter; CA: crude ash; OM: organic matter; NDF: neutral detergent fiber; ADF: acid detergent fiber; CP: crude protein.
a,b,c: Different letters on the same rows indicate statistical difference for Sorghum Sudan Grass GAR (P<0.05).
1, 2, 3: Different numbers on the same rows indicate statistical difference for Sorghum Sudan Grass SG II (P<0.05).

change in sorghum-sudan grass, since CA level is close to that of sorghum-sudan grasses.

It is seen that NDF and ADF contents of sorghum-sudan grass silages prepared by mixing with grape pomace in varying proportions were between 49.68-62.86% and 21.55-42.77%, respectively. While there was a significant difference (P<0.05) in terms of NDF and ADF values of sorghum-sudangrass variety, it was determined that the added grape pomace only was increased the NDF values of Gardavan (GAR) sorghum-sudan cultivars statistically (P=0.05). Grape pomace added to plant crops statistically increased the ADF values of both sorghum-sudan grass silages. It has been reported that the NDF values of the silages prepared from different sorghum-sudan grass varieties are in the range of 68.45-71.53%, the ADF values are in the range of 38.48-43.69%, and there are significant differences between the varieties (Akdeniz et al., 2005). Also, Karadağ and Özkurt (2014) reported that while NDF values of different sorghum sudan varieties were between 62.01% and 62.66% and ADF values were between 39.14% and 40.86%. It is seen that NDF and ADF values of sorghum-sudan grass silages obtained in this study are similar with theese studies. It is thought that the reason of the differences between the varieties is due to the fact that the NDF and ADF values of the grape pomace are higher than the NDF and ADF values of the GAR variety.

CP values of sorghum-sudan silages in this study were between 10.62-13.64%. In a study conducted by Çiğdem and Uzun (2006), the CP values of sorghum x sudan grass varieties ranged from 6.07% (Jumbo variety) to 10.16% (El Rey variety). Karadağ and Özkurt (2014) determined the CP ratio of silage sorghum as a second crop to be 9.45-10.99%. The highest CP values obtained in this studies are similar to the CP values of sorghum-sudan grass silages in mentioned study. The nutrient content of plants differs depending on many factors such as variety, soil structure, harvest period and fertilizer dose used.

Although the effect of grape pomace on the CP values of the silages was not statistically significant (P>0.05), it was observed that the addition of grape pomace to sorghum-sudan silages caused an increase in the CP values of the silages in general.

The parameters regarding to the fermentation quality of the silages are given in Table 3. The pH values of the silages prepared with sorghum-sudan grass were in the range of 3.89-4.87. Grape pomace increased silage pH linearly. Arslan and Çakmakçı (2011) determined that the pH of

Table 3. Fermentation parameters of silages obtained in the study.

	Sorghum Sudan Grass SG II				Sorghum Sudan Grass GAR				
	0	10	20	40	0	10	20	40	P
pH	4,15±0,05^{2}	4,19±0,04^{2}	4,21±0,07^{2}	4,61±0,13^{1}	3,89±0,02^{c}	4,01±0,03^{b}	4,03±0,02^{b}	4,87±0,29^{a}	0.48
Laktic acid,DM%	3,14±0,315^{1}	2,21±0,171^{2}	2,68±0,305^{12}	0,70±0,075^{3}	2,34±0,294	2,60±0,451	1,92±0,074	1,87±0,275	0.38
Asetic acid,DM%	0,63±0,123^{1}	0,65±0,050^{1}	0,66±0,018^{1}	0,38±0,025^{2}	0,24±0,025	0,43±0,131	0,40±0,138	0,61±0,251	0.42
Propionic acid,DM%	0	0	0	0	0	0	0	0	1.00
Bütiric acid,DM%	0	0	0	0	0	0	0	0	1.00
Ammonia nitrogen,DM%	0,57±0,071	0,53±0,021	0,48±0,105	0,60±0,103	0,46±0,051	0,41±0,075	0,48±0,125	0,50±0,085	0.86

SG II: Sugar Graze II; GAR: Gardavan;
a,b,c: Different letters on the same rows indicate statistical difference for Sorghum Sudan Grass GAR (P<0.05).
1, 2, 3: Different numbers on the same rows indicate statistical difference for Sorghum Sudan Grass SG II (P<0.05).

Table 4. The OM degradation values of silages, DM%.

H	Sorghum Sudan Grass SG II				Sorghum Sudan Grass GAR				
	0	10	20	40	0	10	20	40	P
0	10,94±1.10	7,94±0.89	10,21±0.78	6,59±0.65	13,36±1.06 b	18,88±1.36a	19,97±1.23 a	7,56±0.78 b	0.43
2	11,29±0.87[2]	11,71±1.05[2]	12,06±1.76[12]	15,02±1.83[1]	10,02±1.97b	11,70±1.21b	18,4±1.43a	10,90±1.07 b	0.26
4	14,31±1.34[1]	11,70±1.45[12]	15,72±1.23[1]	9,30±1.07[2]	15,63±1.31 a	14,22±1.67a	10,65±1.03ab	16,94±1.87a	0.34
8	16,61±1.32[23]	12,58±1.43[3]	21,26±1.83[1]	17,64±1.11[12]	20,73±1.34b	18,62±1.57b	23,71±1.96a	16,58±121 c	0,08
12	26,52±1.56[1]	19,12±1.65[12]	17,24±1.75[2]	19,91±0.861[2]	22,07±1.55a	20,46±1.11a	29,28±2.12a	25,47±2.54a	0.67
24	38,15±2.03[1]	39,99±1.89[1]	40,09±1.54[1]	32,05±.21[2]	46,68±2.03 a	40,63±2.11b	33,86±2.05 c	25,74±1.78 d	0.45
48	61,09±2.86[1]	56,15±2.32[2]	56,28±2.05[2]	47,63±1.25[3]	65,90±2.89 a	62,89±2.06ab	61,70±2.45ab	58,78±2.01 b	0.25

SG II: Sugar Graze II; GAR: Gardavan;
a,b,c: Different letters on the same rows indicate statistical difference for Sorghum Sudan Grass GAR (P<0.05).
1, 2, 3: Different numbers on the same rows indicate statistical difference for Sorghum Sudan Grass SG II (P<0.05).

sorghum-sudan grass silage without any additives was 3.90. Also, the pH values reported by Keskin *et al*. (2005) for sorghum-sudan grass silage are similar to that of the current study. The silage pH values of the current study were around or slightly above 3.8-4.2 which reported by Ergün *et al.* (2001) that the optimal pH range for silages, but it is in the acceptable range for a good silage. This shows that a good fermentation is formed in silages.

Organic acid levels of silages are presented in Table 3. While sorghum-sudan grass silages are mostly rich in lactic acid, it is seen that grape pomace addition to silages reduce lactic acid levels (P<0.05). While lactic acid levels in sorghum-sudan grass were 0.70-3.14% DM in SG II veriety, these values were 1.87-2.34% DM in GAR variety. The addition of grape pomace in both silages affected the lactic acid profile of the silages, but this effect was more pronounced in the SG II variety (P<0.05). In parallel with the increase in grape pomace level, lactic acid was decreased in both sorghum-sudan grass silages. This change was also reflected in silage pH. It has been determined that sorghum-sudan grass silages contain serious levels of acetic acid. This indicates that these silages are heterofermentative type silages. The amount and profile of organic acid released as a result of fermentation by lactic acid bacteria in silages are related to the sugar content, moisture and buffering capacity of the silage product (Rotz and Muck, 1994). Buffering capacity is lowest among crops in maize, medium in meadow grasses and highest in legumes. For this reason, it is difficult to lower the pH of silage in legumes, and Clostridia, an anarobic bacteria, are vital in these type of siages. These bacteria can ferment sugar, lactic acid and amino acids, resulting in the formation of butyric acid and ammonia-N (Rotz and Muck, 1994). Butyric acid, which is a sign of deterioration or poor quality silage, was not found in the silages of the current study. If not this is a sign that there is no serious problem in the conservation of silages (Ergun *et al*., 2001).

Ammonia-N levels in sorghum-sudan grass silages were 0.41-0.60, % DM and similar (P>0.05). Silage ammonia-N level is an expression of the water-soluble CP level in silages. It is seen that the ammonia levels of the silages change in parallel with the CP

Table 5. The NDF degradation values of silages, DM%.

H	Sorghum Sudan Grass RE				Sorghum Sudan Grass ME				
	0	10	20	40	0	10	20	40	P
0	0,21±1.83	0,73±1.03	3,81±1.23	4,64±1.43	1,81±1.42	0,41±1.71	2,06±0.76	1,83±1.02	0,80
2	1,41±0.89[2]	0,32±1.25[2]	2,08±1.03 [2]	7,85±2.78 [1]	0,0±0.56b	1,70±1.01b	5,15±2.26 a	3,21±1.83ab	0.26
4	3,63±1.52 [2]	0,94±0.78[2]	10,04±2.23[1]	13,22±2,32 [1]	1,31±0.84b	1,00±0.45b	6,58±2.41ab	11,99±3,31 a	0.34
8	3,43±2.36 [2]	1,42±1.78[2]	19,32±3.81[1]	24,64±4.11[1]	0,77±0.36 b	9,76±2.58a	10,22±2.06a	13,74±1.78 a	0.43
12	16,41±2.65a	10,88±3.3a	25,08±3.26[1]	32,18±3.21[2]	5,15±1.65b	10,43±3.27a	16,85±3.11a	17,76±2.87a	0.27
24	33,86±3.95[2]	31,99±3.89[2]	36,11±1.54[12]	41,0±3.86[1]	31,46±3.13a	29,50±3.41a	17,86±3.05b	18,59±3.54b	0.08
48	58,48±4.86[1]	50,20±3.12[12]	51,28±.45[12]	45,20±3.23[2]	54,43±2.98a	49,20±3.16b	53,20±2.45at	48,43±3.12b	0.35

SG II: Sugar Graze II; GAR: Gardavan;
a,b,c: Different letters on the same rows indicate statistical difference for Sorghum Sudan Grass GAR (P<0.05).
1, 2, 3: Different numbers on the same rows indicate statistical difference for Sorghum Sudan Grass SG II (P<0.05).

Table 6. The ADF degradation values of silages, DM%.

H	Sorghum Sudan Grass RE				Sorghum Sudan Grass ME				
	0	10	20	40	0	10	20	40	P
0	1,41±0.92	0,32±0.93	1,31±1.06	0,91±0.86	3,48±1.52	1,12±1.27	1,95±0.96	0,86±0.78	0,58
2	0,69±0.87^{2}	0,85±1.05^{2}	4,83±1.78^{12}	11,32±2.97^{1}	1,78±0.97	1,77±1.01	1,14±1.03	3,64±1.87	0.26
4	0,55±0.74^{2}	0,94±0.89^{2}	5,27±1.58^{12}	10,67±2.65^{1}	3,3±1.21^{b}	0,24±0.67^{b}	1,94±1.37^{b}	14,05±2.78^{a}	0.34
8	1,28±1.10^{2}	5,13±1.87^{2}	17,97±2.12^{1}	20,60±2.88^{1}	1,21±1.06^{b}	1,31±1.11^{b}	4,75±1.03^{b}	18,89±2.21^{a}	0.23
12	12,84±1.76^{2}	9,29±2.15^{2}	25,08±2.89^{1}	32,05±3.21^{1}	13,09±2.15^{b}	6,89±1.96^{b}	13,75±3.12^{b}	30,01±3.58^{a}	0.67
24	33,86±2.53^{2}	31,24±2.59^{2}	36,41±2.51^{12}	41,10±3.41^{1}	21,57±2.73^{b}	26,44±2.26^{b}	15,50±2.15^{c}	31,12±3.87^{a}	0.05
48	60,73±2.98^{1}	44,52±3.13^{2}	48,04±3.25^{2}	43,72±4.25^{2}	41,08±3.59^{b}	41,73±3.61^{b}	45,78±3.24^{ab}	47,4±3.11^{a}	0.25

SG II: Sugar Graze II; GAR: Gardavan;
a,b,c: Different letters on the same rows indicate statistical difference for Sorghum Sudan Grass GAR (P<0.05).
1, 2, 3: Different numbers on the same rows indicate statistical difference for Sorghum Sudan Grass SG II (P<0.05).

content. Grape pulp did not cause a significant change in ammonia-N content in sorghum-sudan grass silages. The change in the CP values of the silages was also reflected in the ammonia levels of the silages.

The *in situ* degradation values of OM, NDF and ADF of sorghum-sudan grass silages are given in Tables 4, 5, 6. Although the degradation values of OM, NDF and ADF obtained after 48 hours of rumen incubation for sorghum-sudan grass variety differ in numbers, they are statistically similar (P>0.05). While OM degradation in silages prepared with sorghum-sudan grass varied between 58.78-65.90% in GAR varieties, these values were in the range of 47.63-61.09% in SG II variety after 48 hours. Addition of grape pomace to significantly reduced OM degradation in both varieties, and the lowest OM degradations were seen in groups containing 40% grape pomace in both groups (P<0.05). NDF and ADF degradation of silages were 48.43%-54.43%, 41.08%-47.42% for GAR variety, and it was in the range of 45.20-58.48%, 43.72-60.73% for SG II variety, respectively. Addition of grape pomace tended to decrease NDF degradation in sorghum-sudan grass silages, while it increased ADF degradation in GAR variety but decreased it in SG II variety (P<0.05). In studies with sorghum-sudan grass silage, it is possible to find DM degradability values of 55-65% depending on the variety and harvest time (Akdeniz *et al*., 2005; Famuyiwa and Ough, 2015). It is stated that the dry matter degradability and degradation values of different grape pomace vary between 16-39% in cattle, sheep and goats (Sarıçiçek and Ünal, 2002; Famuyiwa and Ough, 2015), it is seen that these degradability of dried grape pomace are quite low. In the present study, it is seen that the degradation values of the sorghum-sudan grass silages are similar with the literature reports. Also, the addition of grape pomace to silages in varying proportions reduces the nutrient degredation of the silages, which can be explained by the fact that the degradability of the grape pomace is lower than the nutrient degradation of the plants used in the silage.

Conclusion

As a result, it has been determined that the addition of grape pomace up to 40% to sorghum-sudan grass silages has some negative effects on silage quality, but in general, grape pomace can added to sorghum-sudan grass silages at rates of up to 20%. Thus, it can be used as an alternative roughage in ruminants.

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Author contributions

All authors contributed equally to the study.

Conflict of Interest

The author declare no conflicts of interest.

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