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Silage Quality, Aerobic Stability, Gas Production and in vitro Digestibility of Pumpkin Residue Silages

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Abstract

This experiment was carried out to determine the silage quality of pumpkin residues (PR) with wheat straw (S) and alfalfa hay (AH). The treatment groups were as follows: 1: 100% pumpkin residue (PR), 2: 80% PR and 20% AH (PR80+AH20), 3: 80% PR and 20% S (PR80+S20), 4: 60% PR and 40% alfalfa hay (PR60+AH40), 5: 60% PR and 40% wheat straw (PR60+S40), 6: 80% PR+10% AH +10% S (PR80+AH10+S10) and 7: 40% PR+20%AH+20% S (PR40%+ AH20%+S20%). The lowest dry matter content was observed in the ensiled alone PR (3.90%, P<0.01). The crude protein ratio in the alfalfa-supplemented groups was higher than those of the added groups and PR group (P<0.01). The crude cellulose was lower and NDF higher in the PR group than in other groups and ADF was highest in the 40%S added group. The water-soluble carbohydrate ratio in PR and PR60+10A+10S PR groups was higher than those of other groups. In the PR group, the lactic acid ratio was higher than in the PR80+S10+A10 group. In the PR80 + S20 group, the highest gas production was obtained at the 48th, 72nd, and 96th hours. The energy values of the PR group were higher than those of the other groups.

Kabak Artığı Silajlarının Silaj Kalitesi, Aerobik Stabilitesi, Gaz Üretimi ve in vitro Sindirilebilirliği

Anahtar Kelimeler
Kabak Artıkları, Silaj Kalitesi, Gaz Üretimi, Aerobik Stabilite

Özet

Bu çalışma, kabak artıkları (PR) ile buğday samanı (S) ve yonca kuru otu (AH) kullanılarak hazırlanan silajların kalitesini belirlemek amacıyla gerçekleştirilmiştir. Deneme grupları şu şekilde düzenlenmiştir: 1: %100 kabak artığı (PR), 2: %80 PR ve %20 AH (PR80+AH20), 3: %80 PR ve %20 S (PR80+S20), 4: %60 PR ve %40 yonca kuru otu (PR60+AH40), 5: %60 PR ve %40 buğday samanı (PR60+S40), 6: %80 PR+%10 AH+%10 S (PR80+AH10+S10), ve 7: %40 PR+%20 AH+%20 S (PR40+AH20+S20). En düşük kuru madde oranı, yalnızca PR ile hazırlanan silajda gözlenmiştir (%3,90, P<0.01). Yonca katkılı gruplarda ham protein oranı, saman katkılı gruplar ve sadece PR grubuna göre daha yüksek bulunmuştur (P<0.01). PR grubunda ham selüloz oranı daha düşük, NDF oranı ise diğer gruplara göre daha yüksek bulunurken, ADF oranı %40 saman katkılı grupta en yüksek düzeyde tespit edilmiştir. Suda çözünebilir karbonhidrat oranı, PR ve PR60+10A+10S gruplarında diğer gruplara göre daha yüksek bulunmuştur. Laktik asit oranı, PR grubunda PR80+S10+A10 grubuna göre daha yüksek tespit edilmiştir. Gaz üretimi, PR80+S20 grubunda 48., 72. ve 96. saatlerde en yüksek düzeyde ölçülmüştür. Enerji değerleri açısından, PR grubunun diğer gruplara kıyasla daha yüksek değerlere sahip olduğu belirlenmiştir.

Keywords
Pumpkin residues, silage quality, gas production, aerobic stability

1. INTRODUCTİON

Agricultural residues are left over after the harvesting or processing of various crops. Pumpkins have been produced to obtain seeds, oil, and snacks. After the separation of seed from pumpkin fruit a large amount of residue material emerges (fruit meat and small seeds constitute 95% of the whole fresh fruit, determined by own). In a short harvest period, fresh pumpkin residues cannot be stored a long time as fresh due to high water content (87.5 to 95%) (Mokhtarpour 1994; Church 1996) and microbial deterioration. These residues can be used as fresh feed and silage in ruminant diets. However, not enough trials were carried out to evaluate the pumpkin residue's ensiling ability and silage quality.

Pumpkin fruits are rich in carotenoids, digestible fibre, sugar and pectins. Their sugar and pectin content most of which can be fermented by silage bacteria (Lozicki et al., 2015). When considered as a feed source, it can be beneficial as a nutritious material for ruminants, especially in winter feeding, where livestock may have been fed with poor quality forages (such as cereal straw), which are deficient in carotenoids and vitamin A. It is reported that pumpkin fruits have about 9 to 12% dry matter, 11 to 16% crude protein, 14 to 19% crude cellulose (Mokhtarpour 1994; Church 1996) and 58% total digestible nutrient content (Church 1996). To get high quality silage from various vegetables, dry matter content of materials should be kept about 28 to 35 % (Ozen et al., 1986). So, pumpkins are described difficult ensiling material due to high moisture content (Akyildiz, 1984). In practice, to get optimal limit humidity, and increase dry matter content and prevent seepage of ensiling silage material should be admixed cereal chaff or another hays. In a study, it was reported that the use of pumpkin silage instead of dry roughage at 0, 20, 40 and 60% ratio did not significantly change dry matter consumption, daily live weight gains and feed utilization rate in male buffalo males (Razzaghzadeh et al. 2007). Hashemi and Razzaghzadeh (2007) reported that the carbohydrate ratio of pumpkin wastes (shell and fruit meat) was significantly higher.

Ørskov (1980) recommended that when silage is made from unfamiliar feed materials, the availability of these materials as a feed source, they should be concerned with their effect on appetite and toxicity. There were some efforts on the suitability for silage and feed value of pumpkin residue (Scharrer et al., 1960; Brune and Zaddach 1963; Hashemi and Razzaghzadeh 2007). The purpose of this study is to investigate the possibilities of making pumpkin residue silage with additives such as wheat straw and alfalfa hay and their combinations at various ratios.

2. MATERİAL AND METHODS

Ensiling Process

The pumpkin residues were obtained after pumpkin seed separation using a harvesting machine (Özkanlar Tarım, Kayseri, Turkey). The machine chopped of pumpkin fruits about 3-8 cm length and width. Before to ensiling process, moisture content of pumpkin fruits was measured (two days ago in the same field pumpkin samples) and found between4 to 7% (in experimental samples was 4.7%, Table 1) dry matter (DM). Then pumpkin fruit residues were mixed with straw and alfalfa hay in different proportions in order to reduce moisture. Pumpkin residues were ensiled alone, with straw and alfalfa hay (20 and 40% and their combinations as 10 and 20%). The samples were strictly compacted by hand in 5 liters of jars and remained for two months for fermentation at room temperature (between 20 to 24 °C).

The group descriptions created in the experiment should be written clearly.

Chemical Analysis

The jars were opened at after 60 days and pH of samples were measured according to method of Akyildiz (1984) with a benchtop pH meter (Thermo Scientific Orion 3-Star, Waltham, MA, USA). The dry matter, crude protein, crude ash, crude cellulose and ether extract were determined according to methods specified in AOAC (1990). Neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) were determined according to VanSoest and Robertson (1979). The difference between NDF and ADF values provides an estimate of hemicellulose (HEM). Water soluble carbohydrate (WSC) contents were determined by the phenol sulphuric acid method according to Dubois et al. (1956) and aerobic stability were determined according to Ashbell et al. (1991). Lactic acid (LA) was determined by Lepper's methods (Akyıldız 1984). The acetic, propionic and butyric acid analysis were done in a gas chromatograph with a capillary column (30 m × 0.25 mm × 0.25 µm, Restek), in a Shimadzu GC-2010+ (Kyoto, Japan).

In Vitro Gas Production, Energy Values And Organic Matter Digestibility

Digestible organic matter and metabolic energy (ME) and net energy lactation (NEL) levels of silages in in-vitro conditions were made according to the in vitro gas production technique reported by Menke and Steingass (1988). The tubes were incubated in a shaking water bath at 39 ° C and the amounts of gas formed by fermentation at 0 (start of incubation), 3, 6, 9, 12, 24, 48, 72 and 96 hours.

Cumulative gas production data were fitted to the model of Ørskov and McDonald (1979) by NEWAY computer package program.

$$y = a+b(1-e^{-ct})$$

Where, a, the gas production from the immediately soluble fraction (mL); b, the gas production from the insoluble fraction (mL); c, the gas production rate constant for the insoluble fraction (mL/h); a+b, potential gas production (mL); t, incubation time (h); y, gas produced at time “t”. Organic matter digestibility (OMD), metabolizable energy (ME) [21] and net energy lactation (NEL) (Menke and Steingass, 1988) contents of forages were estimated using equations given below:

OMD,% = 15.38 + 0.8453 x GP + 0.0595 x CP + 0.0675 x CA

ME, MJ / kg DM = 2.20 + 0.1357 x GP + 0.0057 x CP + 0.0002859 x CF2

NEL (MJ/kg DM) = 0.101 GP+0.051 CP+0.112 EE

in the formula: CP:% crude protein, CF:% crude oil, and CA:% crude ash (%).

Statistical Analysis

For statistical analysis of the data obtained from the study, One-way ANOVA was applied by using SPSS 9.05 (1998) program and Duncan multiple comparison test was used to determine the differences among the treatment groups. Probability was accepted as $P<0.05$.

3. RESULTS

For the pumpkin silages, it was observed that in the physical evaluation of the smell, color and structure, they had a pleasant and aromatic scent, a color changed natural yellow to light yellow and in the groups except pure pumpkin, the particles generally did not lose the structure. It was determined that the silage made with pure pumpkin showed a watery and gaseous structure in which the particles were scattered but there was no significant loss in the color. In this case a total of 7 points, "middle" degree has received. Nutrient composition of fresh pumpkin residue is given in Table 1. The dry matter of ensiled pumpkin material was very low (4.70%). The pH, chemical composition, water soluble carbohydrate, aerobic stability and fleig point of pumpkin residue silage with alfalfa and wheat straw are shown in Table 2. The pH value (4.54) in 40% alfalfa supplemented group was significantly higher than other groups and PR group’s pH (3.90) was lower than that of other groups ($P<0.01$).

Table 1. Nutrient content of pumpkin residue before ensiling

Item	DM, %	CP, %	CA, %	NDF,%	ADF, %
Pumpkin residue	4.70	13.76	12.01	51.63	42.05

DM: Dry matter; CP: Crude protein; CA: Crude ash; NDF: Neutral detergent fiber; ADF: Acid detergent fiber.

Table 2. The pH, chemical composition, and their ratio in organic matter, water-soluble carbohydrate, fleig point and aerobic stability of pumpkin residue ensiled with alfalfa hay and wheat straw

	Treatments								
Item	PR	PR80+A 20	PR80+S 20	PR60+A H40	PR60+S4 0	PR80+AH1 0+S10	PR60+AH20 +S20	SE M	P
pH	3.90^{c}	4.15^{bc}	3.97^{bc}	4.54^{a}	4.03^{bc}	3.98^{bc}	4.34^{b}	0.05	0.001
DM, %	7.27c	21.00^{ab}	23.20^{b}	37.87^{a}	36.13 ^{a}	23.73^{b}	30.27^{ab}	2.36	0.001
CP, %	9.61^{b}	13.27^{a}	5.73^{d}	13.27^{a}	5.22^{d}	7.21^{c}	8.68^{b}	0.69	0.001
CA, %	9.77^{a}	9.93 ^{a}	6.97^{c}	10.30^{a}	7.03^{c}	8.10^{bc}	8.70^{b}	0.31	0.001
CF, %	1.70	2.05	1.33	2.22	1.77	1.57	1.98	0.09	0.043
CC, %	29.58^{f}	32.95^{e}	45.25^{b}	37.46^{d}	49.08^{a}	40.93^{c}	40.39^{c}	1.14	0.001
NDF, %	52.24^{a}	48.33^{b}	31.40^{f}	48.67^{b}	35.14^{e}	41.87^{d}	44.13^{c}	1.58	0.001
ADF, %	38.20^{abc}	34.66^{c}	46.53^{ab}	36.53^{bc}	47.33^{a}	38.93^{abc}	32.87^{c}	1.55	0.043
OM, %	90.23d	90.07d	93.03a	89.70d	92.97 ab	91.90 bc	91.30c	0.31	0.001
OMCP, %	10.65b	14.73 ^{a}	6.16d	14.80a	5.62d	7.85c	9.50b	0.79	0.001
OMCC, %	32.78f	36.58e	48.63 b	41.76d	52.80a	44.54c	44.24c	1.42	0.001
OMCF, %	1.88abc	2.28ab	1.43c	2.47 ^{a}	1.90abc	1.71bc	2.17ab	0.10	0.029
WSC, g/kg KM	2.45a	0.86b	1.18b	0.67b	1.03b	0.77b	2.87a	0.22	0.000 1
Aerobic stability	27.00c	99.33a	74.33ab	102.67a	49.00bc	74.00ab	107.67a	7.66	0.01
pH-Aerobic stability	8.1	8.74	9.69	7.68	9.31	9.16	9.32	0.23	0.194
Fleig score	63.53c	80.87 b	92.47 b	99.00 b	116.20a	93.27 b	91.93 b	3.78	0.001
Quality class*	good	very good	very good	very good	excellent	very good	very good	-	-

PR: pumpkin residue, AH: alfalfa hay, S: wheat straw, DM: dry matter, CP: crude protein, CA: crude ash, CF: crude fat, CC: crude cellulose, NDF: neutral detergent fiber, ADF: acid detergent fiber, OM: organic matter, OMCP: crude protein in organic matter, OMCC: crude cellulose in organic matter, OMCF: crude fat in organic matter, SEM: standard error of means, P: probability. *Quality classes determined by Flieg score (100+: excellent, 100-81: very good, 80-61: good, 60-41: satisfactory, 40-21: medium and 20-0: bad). a,b,c,d: The differences between averages with different letters in the same column are significant.

Fleig score calculate based on DM and pH values of silage, the silages samples are classified generally good (only PR) and the other groups have “very good” class. In this study, the fleig score of PR60+S40 group higher than of those other groups, whereas the fleig score in the control group was significantly lower than those of the other groups (p <0.01).

Dry matter content of silage samples was the lowest in alone ensiled pumpkin (7.27%) group and highest in K60+ A40 and K60+ S40 groups (37.87 and 36.13%) (Table 2, P<0.01). Lower concentrations (20%) of A and S mixture was lower DM content in silages. However, PR60?+A10+S10 group pH value was similar K60+ A40 and K60+ S40 groups.

The crude protein content of alfalfa supplemented groups (20 and 40 % alfalfa) were higher than those of other treatment groups and in the S added groups was lower than those of other groups while the lowest protein content was found in the 200 and 400 g/kg S groups. Pumpkin residue group protein content was 9.61% and this ratio higher than those of S added groups.

In the S added groups’ crude ash content were lower than those of other groups (P<0.01). There was no significant effect in terms of crude fat content of samples between the treatment groups. Crude cellulose percentage and its ratio in organic matter was highest in the 40 g/kg S group and followed 20 g/kg S added groups. Single ensiled pumpkin silage had lowest CC content (P<0.01). The highest NDF content was observed in the single pumpkin residue group and NDF content lowered by straw addition (P<0.01), however, the ADF content of straw-supplemented groups was higher than those of other groups (P<0.05). Also, 20% and 40% straw addition caused an increase in organic matter content compared to other groups (P<0.01). The crude protein ratio in the organic matter 20 and 40% alfalfa group was higher than those of 20 and 40% straw-added groups (P<0.01). In the 40% alfalfa group crude fat ratio in the organic matter was higher than those of 20% S and 80% PR+10%A+10%S groups (P<0.05).

The effects of pumpkin residue silages on lactic, acetic, butyric, propionic acid and ethanol concentration of silages are given in Table 3. The lactic acid concentration (45.01%) of K60+S40 group was lower than those of the PR and PR80+S10+A10 groups. The ratio of acetic acid, butyric acid and propionic acid in the silage samples were not significantly differ among the groups. The ethanol ratio was highest in the PR group and this group’s ethanol concentration significantly differ from PR80+B20,PR80+B10+S10, and PR60+B20+S20 groups. The time-dependent gas production rate of silage samples is given in Table 4. In group C, the gas production from quickly soluble fractions (a) (-10.22) was very high and in the PR60+S20+A20 group (4.21) lower (P<0.05). According to the time-dependent gas production, the maximum gas production was in the PR80+S20 (60.70) group and the lowest in the PR60 + A40 (48.91) group (P<0.01).

Table 3. Effects of various additives used in the silage of pumpkin residues on organic acids

Treatments	LA, %	AA, %	BA, %	PA, %	Ethanol, %
PR	53.90[a]	16.13	0.00	3.56	5.45 [a]
PR80+AH20	50.23[ab]	15.89	0.97	2.65	3.13[b]
PR60+AH40	53.56[a]	15.74	0.82	2.85	3.49[ab]
PR80+S20	47.62[ab]	18.12	1.26	2.66	3.97 [ab]
PR60+S40	45.01[b]	15.63	0.00	2.69	3.54 [ab]
PR80+S10+AH10	52.67[a]	17.03	0.48	3.53	4.24[b]
PR60+S20+AH20	48.29[ab]	15.91	0.00	3.40	4.39[b]
SEM	0.93	0.33	0.17	0.15	0.18
P	0.042	0.379	0.234	0.382	0.001

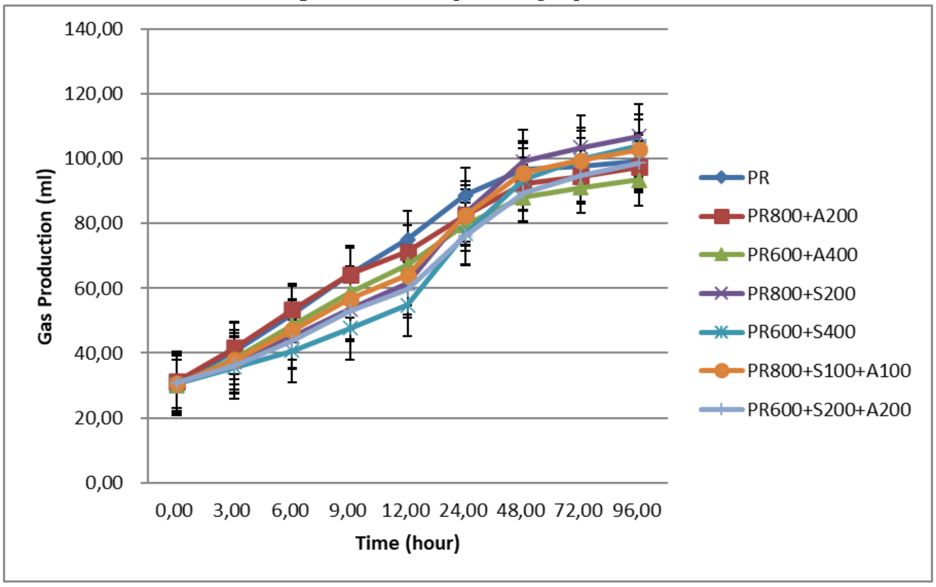
PR: pumpkin residue, AH: alfalfa hay, S: wheat straw, LA: Lactic acid; AA: Acetic acid; BA: Butyric acid; PA: Propionic acid; SEM: Standard error of the averages; P: probability; a, b: The differences between averages with different letters in the same column are significant.

Table 4. pH of different pumpkin residue silages, gas composed of readily soluble fraction, time-dependent gas and gas production rate

Treatments	pH	a	b	c	RSD
PR	6.73[b]	-10.22[b]	58.25[ab]	0.11 [a]	1.327
PR80+A20	6.77[a]	-4.40[a]	48.99 [c]	0.09 [a]	1.537
PR80+S20	6.64[d]	-5.64 [a]	60.70 [a]	0.05[b]	0.943
PR60+A40	6.79[a]	-6.17 [a]	48.91[c]	0.09 [a]	1.370
PR60+S40	6.65[d]	-5.70 [a]	59.81 [a]	0.04[b]	1.673
PR80+S10+A10	6.69[c]	-4.65 [a]	55.09[abc]	0.06[b]	0.800
PR60+S20+A20	6.72[b]	-4.21 [a]	51.63[bc]	0.05[b]	1.117
SEM	0.012	1.326	2.112	.006	-
P	0.001	0.081	0.004	0.001	-

PR: pumpkin residue, AH: alfalfa hay, S: wheat straw, a: the gas production from the quickly soluble fraction (mL); b: the gas production from the insoluble fraction (mL); c: the gas production rate constant for the insoluble fraction (mL/h);SEM, standard error mean; P: probability. RSD: residual standard error, a,b,c,d: The differences between averages with different letters in the same column are significant.

Graphic 1. Time dependent gas production



The rate of gas production in the alone PR group was higher than those of the other groups in the 3, 6, 9, 12 and 24 h, however, PR80+A20 The amount of gas released during the 96-hour fermentation period in the study material pumpkin residue silages is given in Table 5. The gas production rate of PR80 + S20 group was the highest at 48th, 72nd and 96th hours (P<0.01) and the gas production rate of PR60 + A40 group was lower at 72 and 96 hours (P<0.01).

The organic matter digestibility (OMS), metabolic energy (ME) and net energy lactation (NEL) values calculated using the in vitro production volumes of the study material pumpkin residue silages are given in Table 6. In the control group's the OMD, ME and NEL values were significantly higher than those of other groups (without PR80+A20 group, P <0.05).

Table 5. Gas production in pumpkin silages during fermentation

Treatments	Fermentation duration, h							
	3.00	6.00	9.00	12.00	24.00	48.00	72.00	96.00
PR	40.50^{a}	52.17^{a}	64.33^{a}	75.17^{a}	88.67^{a}	96.67^{ab}	97.67^{bc}	99.33^{cd}
PR80+A20	41.67^{a}	53.33^{a}	64.33^{a}	71.33^{ab}	82.50^{abc}	92.33^{abc}	94.67^{cd}	97.50^{d}
PR80+S20	37.33^{bc}	45.17^{cd}	53.50^{c}	61.66^{d}	83.16^{ab}	99.17^{a}	103.50^{a}	107.00^{a}
PR60+A40	38.33^{b}	48.67^{b}	58.83^{b}	67.33^{bc}	79.50^{bc}	88.17^{c}	91.17^{d}	93.50^{e}
PR60+S40	35.67^{d}	40.67^{e}	47.67^{d}	54.83^{e}	76.83^{bc}	93.67^{abc}	99.83^{ab}	104.00^{ab}
PR80+S10+A10	37.83^{bc}	47.00^{bc}	56.67^{bc}	64.00^{cd}	82.50^{abc}	95.67^{abc}	99.50^{abc}	102.83^{bc}
PR60+S20+A20	36.33^{cd}	43.67^{d}	53.00^{c}	59.50^{d}	76.17^{c}	89.50^{bc}	94.83^{bcd}	98.67^{d}
SEM	0.51	0.71	1.25	1.52	2.02	2.34	1.54	1.22
P	0.001	0.001	0.001	0.001	0.010	0.050	0.001	0.001

PR: pumpkin residue, A: alfalfa, S: straw, SEM: standard error of means; P: probability, a,b,c,d: the differences between averages with different letters in the same column are significant.

Table 6. Organic matter digestibility (OMS), metabolic energy (ME), and net energy lactation (NEL) values in pumpkin residue silage

Treatments	OMS %	ME (MJ/kg KM)	NEL (MJ/kg KM)
PR	58.15^{a}	8.61^{a}	5.03^{a}
PR80+A20	54.55^{ab}	8.02^{ab}	4.62^{ab}
PR80+S20	51.88^{b}	7.72^{b}	4.29^{b}
PR60+A40	53.36^{b}	7.83^{b}	4.54^{b}
PR60+S40	51.07^{b}	7.48^{b}	4.28^{b}
PR80+S10+A10	52.11^{b}	7.73^{b}	4.34^{b}
PR60+S20+A20	50.62^{b}	7.48^{b}	4.22^{b}
SEM	1.599	0.244	0.182
P	0.027	0.031	0.033

PR: pumpkin residue, A: alfalfa, S: straw, ME: metabolizable energy; NEL: net energy lactation; OMD: organic matter digestibility; SEM: standard error of means; P: probability, a,b: Significances between individual means were identified.

DİSCUSSİON

Silage quality can be predicted objectively as a tool for preliminary assessment (Ozen et al., 1986). Subjective evaluation may give a clue for silage quality without any chemical analysis results. In this experiment there was no substantial change of pumpkin residue particle size in the silage samples. DLG score (1997) in silages made with corn varieties sum of the smell, structure, and color scores may contribute to predicting silage quality classification and it can be detected by the sensory organs. The additives used to reduce the amount of water in the pumpkin residue silages changed the physical appearance of the silage, which made it possible to get a high score in terms of these criteria. Konca et al. (2005) found that silage quality class was satisfactory in pea silages in unusual feed materials in silage production, bad and satisfactory in triticale silages, good for artichoke silage, and satisfactory for corn silages.

The pH value ranges of this experiment can be evaluated for success a good silage quality. According to recommendation of good quality silage pH ranges should be 3.5 to 4.0 (Ozen et al., 1986). It has been reported that when pH is not low enough, there was not a sufficient fermentation, so, it is presumably assumed silage is not harvested at an appropriate time, or insufficient carbohydrate provided for fermentation and therefore lactic acid bacteria are not developed (Ozen et al., 1986; Kutlu, 2014). Especially, when occurred insufficient fermentation, the pH of the silage does not fit decrease sufficiently, not enough lactic acid formation but undesirable butyric and propionic acids increase in the silo (Ozen et al., 1986). In the current experiment the pH value of silages was generally around 4.0 and it can be said to be sufficient fermentation well done.

The dry matter of ensiled alone pumpkin residue was very low (4.70%). Dry mater of silages was increased by the alfalfa hay and straw supplemented groups. Scharrer et al. (1960) reported that fresh pumpkin and silage pumpkin alone nutrient composition were DM: 8.81, 8.01; CP: 1.48, 0.99; CF: 1.08, 0.23; crude fibre: 1.07, 1.21, N-free extract 4.49, 4.39 and CA 0.69, 1.18. Also, Hashemi and Razzagzadeh (2007) added 28.6% straw and 0, 10 and 20 molasses and 5% urea to pumpkin residue and they found that 10% molasses addition increased DM content of silages (37.68%). Church (1996) reported that the pumpkin fruit dry matter content was 9% and Mokhtarpour (1994) found 12.5%. Both of these researcher results of DM values are higher than the values in the current study. However, it has been reported that the variety of pumpkin and harvest time may significantly affect the content of DM (Hashemi and Razzagzadeh 2007). Silage DM is accepted as an important criterion in silage compaction and aneorobic fermentation and harvest time signal. The expected rate of DM in a good quality maize silage is accepted as 30 to 35% (Konca et al., 2005). From this point of view, it can be said that the DM rates in the silage samples high and low values from these ranges are not suitable for good quality silages. On the other hand, in the silages obtained from seasonally grown plants and sometimes insufficient maturation, so, lower DM ratio than that of desired values and dry rough feeds such as hay or straw were mixed into the silage material to prevent seepage losses due to high moisture content. In this study, wheat straw and alfalfa hay were used to reduce the high humidity content of pumpkin residues and it was observed that the content of DM reached to the desired (DM> 35%) levels especially in groups with 40% straw and alfalfa (Table 2). Kara et al. (2009) reported that broccoli, parsley, lettuce, leek, cauliflower, cabbage and spinach contain low dry matter than that of pumpkin residues and from these reports it has been determined that pumpkin residue is a silo material with better quality of crude nutrient content than most of vegetable residues.

Fleig score calculate based on DM and pH values of silage, the silages samples were classified generally good (only PR) and the most of groups have "very good" class quality. Hashemi and Razzagzadeh (2007) found that ensiling of PR with molasses and urea pH value ranges between 7.61 and 6.24 while Invanchuk (1984) determined the pH value in the pumpkin silage between 4.4 and 4.5 and Mokhtarpour (1994) reported that pH of pumpkin prior to ensile was 5.9 and after fermentation ranged from 3.87 to 4.54 and these pH values similar as the current experimental pH values. Konca et al., (2005) reported that fleig scores in the silages produced (such as peas, artichoke, triticale, and corn) in dairy cattle farms of Turkey were between 11.0 and 98.5and they have been classified between the "bad" and the "very good" quality. Kara et al., (2009) found that the quality class of lettuce, leek, cauliflower and cabbage was "satisfactory" and celery, broccoli and parsley and spinach was not suitable for make silage. The highest fleig score was 83.94 in leek, and the lowest in 15.66 broccoli. These values obtained are more satisfactory than the values obtained for the other materials which are ensiled as by-products. In the commercial farms, maize silage quality may be changed between 'middle' and 'famously' quality classes (Alçiçek 1995).

The crude protein content alone PR group was 9.61% and their results were similar to Enishi et al. (2004) results who reported that pumpkin residue crude protein content was 9.4 %. Alfalfa added groups' crude protein ratio were higher than those of other groups. Alfalfa hay contains a high crude protein ratio compared to straw (13.2 vs 4.02%, respectively (analyzed results). Bakshi et al. (2016) noted that protein content of pumpkin was 15.1 and Mokhtarpour (1994) and Church (1996) noted that crude protein of pumpkin silage about 11 to 16%. Other researchers reported low CP content of pumpkin and corn grits mixture (2015). However crude protein content was higher than that of corn silages (Konca et al., 2005) and similar to NDF and ADF content and crude ash.

The wheat straw addition decreased crude ash content of pumpkin residue silages. Crude fat content was not influenced by the treatments. Lozicki et al., (2015) reported that pumpkin fruit ash was 86.4 g/kg. Hashemi and Razzagzadeh (2007) found that dry matter content of pumpkin (71.4%)+straw (28.6%) silage was 8.38%; and also found the highest in the group with 10% molasses added as 37.68%. Enishi et al., (2004) reported that pumpkin residue NDF content was 9.4 % and 25.1% respectively and higher digestibility in goat rumen compared to sugar beet pulp and carrot juice residue. Lozicki et al., (2015) determined that NDF and ADF content of pumpkin alone was 21.7 and 18.0%, respectively.

It is known that short chain volatile fatty acids such as acetic, propionic and butyric acid prevent aerobic deterioration in silage by suppressing the growth of yeast and mold in silage. [34] The lowest lactic acid concentration (45.01%) was obtained in K60 + S40 group and highest lactic acid ratio (58.97%) observed in the PR90 + B10+S10 group. The ratio of acetic acid, butyric acid and propionic acid in the silage samples were not significantly differ between the groups. Ethanol ratio was highest in PR80 + Y20 group and lowest ethanol concentration was obtained in K90 + A10 group. Invanchuck (1984) found 10.2 g of lactic acid, 1.3 g of acetic acid and 0.83 g of butyric acid per kilogram of pumpkin silage. Brune and Zaddach (1963) noted that when pumpkin ensiled with stubble alfalfa and sunflower up to 1/3 ratio evaluated “very good quality” in terms of acid content, digestibility and feeding value. Researcher claimed that pumpkin and corn silage was better quality than corn alone, higher crude protein digestibility with 2: 1 or 1: 1 ratio. Butyric acid was not detected in the silage of PR alone, PR60+S40 and PR80?+S20+A20 groups. Butyric acid is generally low in feeds made with good silos.

Improvement of rumen conditions is important in terms of cellulase hydrolysis. In terms of cellulasis, it can be desired pH values should be changed between 6.6 and 6.8, and if increase or decrease occurs in the rumen pH value it may affect cellulose digestibility. In particular, the pH value is less than 5.9, which suggests a decrease in cellulite activity (McDonald et al., 1991). In this experiment, the pH value was higher than 6.0 which create desirable range. As seen in the Table 2, while depend WSC content of samples in group C the gas production from quickly soluble fractions (a) (-10.22) was very high and in the PR60?+S20+A20 group (4.21) lower gas production was observed ($P<0.05$). According to the time dependent gas production, the maximum gas production was in the PR80 + S20 (60.70) group and the lowest gas production was in the PR60 + A40 (48.91) group. The rate of gas production in the control group was higher than those of the other groups. The amount of gas released during the 96-hour fermentation period in the study material pumpkin residue silages is given in Table 4. The gas production rate of PR80 + S20 group was the highest at 48th, 72nd and 96th hours ($P<0.01$) and the gas production rate of PR60 + A40 group was low at 72 and 96 hours ($P<0.01$). In the control group’s the OMD, ME and NEL values were significant higher than those of other groups ($P <0.05$).

Examining Table 2, it will be seen that there is no statistically significant difference between the groups in terms of WSC values for pumpkin residue silages. However, the WSC values obtained in this study were found to be closer to the values determined in legumes (Keleş et al., 2013) than the WSC values of corn silage (Polat et al., 2005) reported by other researchers. In many cases, materials with high WSC content have the advantage of providing suitable fermentation development (Davies et al., 1998). If there is not enough WSC in the medium, silage quality will decrease. In order to get a better quality silage, it must be contained at least 3 to 5% fermentable carbohydrate in DM, especially hexoses. From this point, it can be said that the WSC content of the pumpkin residue silages is sufficient to get good quality silage.

The time-dependent gas production rates are given in Table 4. When the in vitro gas production kinetics are considered, the highest group was the PR60 + S40 (pH = 6.79) group and the lowest value was in the PR80 + S20 (pH = 6.64) group. However, it has been found that the pH change intervals are very narrow and vary between 6.79 and 6.64. Differences in nutrient content of feeds may affect in vitro gas production parameters, energy values and OMD in silages (Kılıç and Boğa, 2009). Similarly, in this study, it can be seen that between the gas production values of the groups varied in different silage groups. In the present study, organic matter values were higher in the PR80 + S20 and PR60 + S40 groups and NDF values were lower than those of other groups. At the same time, the PR80 + S20 group’ gas production at 48th, 72ndand 96th hours significantly higher than the other groups. In this matter, differences of silage samples nutrient compositions may explain of difference of gas production values. On the other hand, protein concentration of samples may effect of gas production and high percentage of feeds negatively effect of gas production (Kılıç and Boğa, 2009). Similarly, in this study, the PR60 + A40 group could explain the fact that it has less gas production value than those of the other groups.

Organic matter digestibility, metabolizable energy and lactation net energy values were higher in PR alone silage samples, these values were higher than those of the other groups (without PR80+A20 group). It shows PR alone silage have a better digestibility, NDF ratio and higher gas production. Both alfalfa hay and wheat straw mixture decreased these values. Especially, as well known straw chaff lower digestibility and feed value. Thus, pumpkin residues can be used as a valuable silage material in terms of higher digestibility and energy value.

CONCLUSİONS

Agricultural residues and agricultural by-products remain in the production areas and can cause environmental pollution. This study showed that pumpkin residues can be ensiled together with 40% alfalfa hay and/or wheat straw.

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