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The Effects of Different Additives on the Fermentation and Physical Characteristics of Lenox Silage

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Summary: The study was conducted to determine the effects of different additives on the fermentation and physical characteristics in Lenox Silage. For this purpose, Lenox sample was collected and chopped by using scissors. Then, Lenox was treated with 10% barley (B), 0.5% formic acid (FA), 5% sugar (S), and 5% molasses (M), respectively. Treated lenox samples with silage feed additives were ensiled in glass jar with 5 replicates for 90 days and, the silage was analyzed in terms of physical characteristics and fermentation pattern. The results revealed that the smell of Lenox silage in molasses and sugar group was significantly better in all other groups ($P<0.05$). No statistical difference was observed among all the groups in terms of structure and color value ($P>0.05$). Dry matter of the silage was significantly affected by addition of barley and molasses ($P<0.05$). Flieg point significantly increased by addition of molasses, but pH decreased ($P<0.05$). It was also found that ammonia-nitrogen/total nitrogen (NH_3-N/TN) concentration of the silage ranged from 0.48 to 0.67% but the difference between them was not statistically significant ($P>0.05$). Based on the results, Lenox silage can be used as an alternative in the field of animal nutrition and in the future studies.
Key words: Fermentation, lenox, silage

Farklı Katkı Maddelerinin Lenox Silajının Fermantasyon ve Fiziksel Özellikleri Üzerine Etkileri

Özet: Bu araştırma farklı katkı maddelerinin Lenox silajının fermantasyon ve fiziksel özellikleri üzerine etkilerini belirlemek için yapılmıştır. Bu amaçla, lenox örnekleri toplanmış ve makas kullanılarak parçalanmıştır. Lenox sırasıyla %10 arpa, %0,5 formik asit, %5 şeker ve %5 melas ile muamele edilmiştir. Silaj katkı maddeleri ile muamele edilen lenox cam kavanozlara beş tekerrürlü olarak 90 gün boyunca silolanmış ve silaj fermantasyon özellikleri ve fiziksel nitelikleri bakımından analiz edilmiştir. Melas ve şeker ilavesi yapılan lenox silajındaki koku, diğer gruplara göre önemli derecede iyileşmiştir ($P<0.05$). Gruplar arasında renk ve strüktür bakımından istatistik bir farklılık oluşmamıştır ($P>0.05$). Lenox silajına arpa ve melas ilavesi ile silajın kuru madde içeriği önemli derecede etkilenmiştir ($P<0.05$). Melas ilavesi ile Flieg puanı önemli derecede artmış, pH değeri azalmıştır ($P<0.05$). Silajın amonyak-azotu/toplam azot (NH_3-N/TN) konsantrasyonu %0.48 ile %0.67 arasında değişmiş ama aradaki fark istatistiki olarak önemli bulunmamıştır ($P>0.05$). Bu sonuçlar göz önüne alındığında, lenox silajının hayvan besleme alanında ve ileriki çalışmalarda alternatif olarak kullanılabileceği ortaya çıkmıştır.
Anahtar kelimeler: Fermantasyon, lenox, silaj

Introduction

Turkey is situated in large Mediterranean geographical location, covering diverse regions that have different climates because of irregular topography. Although its coastal areas have moderate climatic conditions, inland areas of Anatolia are characterized by harsh hot summers and cold winters (Saadi et al., 2015). This region has some disadvantages in terms of extreme and harsh long winter conditions that limit animal and crop production (Neumann et al., 2016). It may not be possible to for animals to graze on natural rangelands of the region due to the necessity of keeping them inside during winter (Johansen et al., 2017). Thus, forage is required as silage and grass to maintain meat and milk productivity during winter season. Being required for microbial fermentation (Chaucheyras and Fonty, 2001), roughage is the essential feedstuffs in ruminant ration. This situation is associated with the fact that there is a very serious lack of quality in forage in Turkey (Gemalmaz and Bilal, 2016). It becomes an advantage because silage supplies the need of quality in forage together with water especially when considering green feeds that are not available in winter (Şahin and Zaman, 2010).

Silage making technique has been extensively used in the Mediterranean region since 19th century. Maize was first ensiled in Hungary in 1860s (Neumann et al., 2016), and soon after in Turkey in 1931 (Şahin and Zaman, 2010). Silage is made of forages (e.g. Lucerne, maize, sorghum or other cereals), crop residues, agricultural or industrial by-products (Neumann et al., 2016). Silage is the main feedstuffs source for dairy and beef cattle ration (Cogan et al., 2017) supplied as high- energy forage (Rowghani and Zamiri,

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2009). Economy depends naturally on agriculture because of being mainly based on animal production (Kara, 2016). Making good silage depends on adequate level of water soluble carbohydrates, anaerobic condition, exclusion of oxygen, pH level in silage (3.8 -4.2), low buffering capacity of the crop, moisture of green material, optimal temperatures, and nutritive value of the material (Neumann et al., 2016). By means of the silage additives that should be used to improve silage management. Silage additives such as absorbent (wheat, grain, sugar beet pulp), fermentation stimulants (microbial inoculants) and fermentation inhibitors (organic salts) have been used for years to improve the silage quality (Muck et al., 2018).

Mostly, corn silage has been used because of its dry matter yield, high energy level, and good fermentation ability (Ayaşan, 2011). For this reason, it can be asserted that the use of silage is essential to supply the increasing demand of forage in Turkey. Lenox is an annual forage plant grown in the all types of soil. It is planted as alfalfa and wheat at the 1.5-2 cm depth by using a mechanical or pneumatic drill. Lenox is harvested as 10-15 ton/decare per year in the fertilized soil. Being one of the fast-growing species, Lenox has a small leaf, a thick and brittle stem, and a height of 2-3 m within a year.

Lenox feed is added into the ration as green grass or silage. It contains crude protein in leaf and stem, by 22% and 18% respectively. Its silage contains crude protein of 20% and energy of 2400 kcal/kg (Ayaşan, 2011). Lenox (Brassica Rapa cultivar Polybra variety) is called “grass type of turnip or forage rape” (Ayaşan, 2011). Brassica cultivar, which have been used as forage for centuries. Short-season and full-season ones. While short-season Brassica cultivars include forage rape, full-season Brassica cultivars are kale (Brassica oleracea var. acephalia) and collards (Altınok and Karakaya, 2003). Both leaves and root of turnip (*Brassica Rapa L.)* are favorably consumed by dairy and beef cattle (Gemalmaz and Bilal, 2016).

In recent years, Lenox silage has been used in some cities of Turkey such as Kars, Artvin, and Burdur. However, there is not enough number of studies on Lenox silage and its effective usage on animal feeding in the literature. Therefore, the aim of this study was to determine the effects of different silage additives (Barley, molasses, formic acid, and sugar) on fermentation pattern and physical characteristics of Lenox silage.

Materials and Methods

This experimental study was conducted under laboratory conditions at the Animal Nutrition and Nutritional Diseases Department in the Veterinary Faculty of Mehmet Akif Ersoy University located in Burdur (37° 43' North; 30° 16' East) in Turkey.

Preparation of lenox silage

To clarify the process, Lenox seeds were initially planted using 2-cm deep split row planter on 23 September 2014. Following this procedure, Lenox sample was planted during flowering stage from the farm between 15 March and 1 May 2015. Annual average temperature was about 15.1-16.2 °C in autumn and 11.6-12.6 °C in spring in Burdur.

Lenox was chopped into small pieces (2-2,5 particle length) cm size with a knife and scissors. Then, the silage additives were properly mixed with fresh Lenox in a basin. Mixed materials were ensiled in the 1-L glass jars by tamping in the laboratory. Then, five 1-L glass jars (100 mm in diameter x 170 mm in height) were filled for each treatment and a total of 25 glass jars were used in this experimental study. The treatment groups were 10% barley (B); 0.5% formic acid (FA); 5% (glucose) sugar (S), 5% molasses (M) and control (no additive-C) groups. After silages were kept at room temperature for 90 days, the silages were taken for analysis of dry matter content, silage pH, physical characteristics (PC), and Flieg point.

Experimental procedure, measurement, and analysis

Silage pH levels were determined using pH meter (Ecomet pH/mV/TEMP Meter p25) in silage extracts, prepared by adding 125 g demineralized water into 25 g silage and homogenizing it in a laboratory blender for 5 min (Filya, 2003). The Kjeldahl method and a Vapodest 10 Rapid Kjeldahl Distillation Unit (Gerhardt, Konigswinter, Germany) were used to find total value of NH_3-N/TN (Broderick and Kang, 1980). While nutrient composition of Lenox plant was determined according to the AOAC (AOAC, 2003), crude fiber was determined by using the methods of Crampton and Maynard (Crampton and Maynard, 1938). The metabolizable energy levels of Lenox hay (Table 1) were determined by the methods of TSI (TSI, 1991). Its physical characteristics were determined by 3 researchers. Color properties (according to quality scores 0, 1 and 2), structure properties (according to quality scores 0, 1, 2 and 4) and smell properties (according to quality scores 0, 2, 4, 8 and 14) were determined according to the method of Kılıç (Kılıç, 1986). The quality score was divided into four as good total score (14-20), middle total score (10-13), utilizable total score (5-9), and low total score (0-4). Flieg point was calculated by using silage pH and dry matter content according to the following formula: [220 + (2 x Dry matter - 15) - 40 x pH] (Kara et al., 2009).

Statistical analysis

SPSS program (SPSS Inc., Chicago, IL, USA) was used with inferential statistics to analyze quantitative data. More specifically, the data were analyzed using one-way ANOVA and significant differences were calculated using Duncan's test (Dawson and Trapp, 2001) to determine whether or not any statistically significant result was found in the present study. The value of P<0.05 was accepted as significance level.

Results

The main purpose of the present study was to see the effects of different feed additives on fermentation pattern and physical characteristics of Lenox silage. After the process, the results revealed that the nutrient content of upper part of the plant was higher compared to its lower part, as it can be seen in Table 1 regarding the nutrient content in chemical composition of the Lenox (%).

The results of the present study also showed that physical characteristics of Lenox silage (smell, structure and color) had statistically significant effects on the groups in terms of the quality (Table 2). Moreover, the smell of silage in formic acid group was less than in the other groups. Total quality score was significantly higher in formic acid group than in all the other groups and ranged from 15.00 to 19.50 points.

Differences in dry matter (%) of Lenox silage were found to be significant (P<0.05) between the groups (Table 3). Barley group had the highest mean DM of 20.04 %, which was significantly higher than control group. The Lenox silage DM percentage was determined as lowest (15.27%) in FA group, which was less than Barley group at the rate of 20.04 %. However, no statistically significant difference was observed between sugar and control groups in terms of dry matter.

Highly significant differences were observed among all the groups in terms of flieg point of the Lenox silage (Table 3). Molasses group (84.08) had a significantly higher flieg point than all the other groups. The control group had the lowest Flieg point (51.20). Similar results were obtained from barley, sugar, and formic acid groups.

Analysis of pH values revealed significant differences (P<0.05) among the groups (Table 4). While the high-

Table 1. Chemical composition of Lenox hay (Dry matter, %)

	Upper part of Stem	Lower part of Stem
Dry matter (%)	89.85	89.72
Ash (%)	8.39	11.74
Organic matter (%)	81.46	77.98
Crude fiber (%)	22.29	30,79
Ether extract (%)	6.01	3.62
Crude protein (%)	21.77	17.58
Metabolizable energy (kcal/kg)	2229.45	1801.32

Table 2. Physical characteristics of (smell, structure and color) Lenox silage

Group (n=5)	Smell	Structure	Color	Total	Quality
Control	13.25^{ab} ±0.28	3.67 ± 0.01	2.00 ± 0.01	18.92^{ab} ±0.28	Good
Barley	13.20^{ab} ±0.25	3.53 ± 0.08	2.00 ± 0.01	18.73^{ab} ±0.29	Good
Formic acid	$12,66^{a}$ ±0.56	3.46 ± 0.13	1.74 ± 0.19	17.86^{a} ±0.87	Good
Sugar	13.93^{b} ±0.06	3.67 ±0.01	2.00 ± 0.01	19.60^{b} ± 0.06	Good
Molasses	13.93^{b} ±0.06	3.67 ± 0.01	1.94 ± 0.06	19.54^{b} ±0.08	Good
P	0.03	0.19	0.26	0.07	

a,b,c Means with different superscript in the same column are different (P<0.05).

Table 3. The effects of various silage additives on dry matter and Flieg point in Lenox silage

Group (n=5)	Control	Barley	Formic acid	Sugar	Molasses	P
Dry matter	16.75^{a} ±0.52	20.04^{b} ± 0.85	15.27^{a} ± 0.63	16.74^{a} ± 0.18	19.14^{b} ±0.25	0.01
Flieg Point	51.20^{a}±5.86	66.11^{a}±2.50	56.66^{a} ±7.20	60.55^{a}±8.59	84.08^{b}±2.24	0.001

a,b Means with different superscript in the same row are different (P<0.05).

Table 4. The effects of various silage additives on pH value and NH_3-N/TN (DM%) in Lenox silage

Group (n=5)	Control	Barley	Formic acid	Sugar	Molasses	P
pH value	4.68^{ab}±0.16	4.68^{ab}±0.15	4.47^{ab}±0.02	4.44^{ab}±0.08	3.98^{a}±0.06	0.001
NH_3-N/TN	0.67±0.06	0.69±0.01	0.66±0.21	0.65±0.07	0.48±0.06	0.81

^{a,b} Means with different superscript in the same row are different (P<0.05).

est pH value was obtained from control group (4.68). Molasses group had significantly the lowest pH value among all the other groups. However, pH value of Lenox silage was similar to the control and barley groups (averagely 4.68%). Addition of sugar decreased pH value, if insignificantly (P<0.05).

There was no significant difference among the groups in terms of NH_3-N/TN (Table 5). Molasses group had lower mean NH_3-N/TN (0.48%) than that of the other groups, which was insignificant. NH_3-N/TN was averagely 0.66%, similar to the three silages.

Discussion and Conlusion

Physical characteristics (smell, structure, and color) of Lenox silage were significantly effective among the groups. The highest total score (smell score + structure score + color score) was observed in sugar group (19.60), whereas, the lowest total score was observed in formic acid (17.86). Toruk and Kayışoğlu (2008) reported that physical characteristics (smell, structure, color) of the corn silage was not effective at d 15 but smell and structure scores were higher than those of control group at d 80 (Toruk and Kayışoğlu, 2008). In the present study, the total quality score was higher in molasses group but lower in barley group compared with the control group, which was similar to the result obtained by Çetin, who found that addition of barley decreased total quality score of feed turnip silage (Çetin, 2017).

The flieg point of control group was significantly the lower compared to the other groups. The results of the present study were similar to those reported by Toruk and Kayışoğlu, who stated that flieg point in supplemented silage was higher than in non-supplemented corn silage (Toruk and Kayışoğlu, 2008). Researches (Toruk and Kayışoğlu, 2008) indicated a strong positive correlation between flieg point and silage quality. Flieg point was positively correlated with dry matter; whereas, it was negatively correlated with pH value of silage. Dry matter in Lenox silage with treated molasses was higher than control group but pH level was relatively lower. Thus, it can be suggested that the highest flieg point was observed in Lenox silage with treated molasses. In the present study, addition of formic acid decreased dry matter ratio and silage pH compared to the control group. The dry matter concentration in grass silage with barley was significantly higher and the pH value was significantly lower compared to the control group and formalin group (Haigh and Davies, 1998). The another study (Silva et al., 2016) stated that the low pH value in silage is desirable to enhance the fermentation quality. It is possible that a quick in drop in pH causes the limitation of proteolysis and inhibits the spoilage microorganism in alfalfa silage. The ammonia-N level significantly decreased with addition of formic acid. In the present study, dry matter level and flieg point were significantly higher in Lenox silage treated with molasses; whereas, pH level and NH_3-N/TN were lower compared to control group. Researcher (Sanchez-Duarte et al., 2014) reported that a lower pH and higher NH_3-N was observed in canola silage *(Brassica napus L.)* compared to alfalfa silage *(Medicago sativa)*. The effect of molasses was similar to that which was the results (Baytok et al., 2005) indicating that its usage significantly increased dry matter; however, it had no effect on pH. Nishino et al. reported that addition of molasses into grass silage increased dry matter; whereas, pH level and NH_3-N/TN concentration reduced at the end of 56-d (Nishino et al., 2012). The results of this trial showed that the sugar used in Lenox silage decreased dry matter concentration and pH while enhancing flieg point. The dry matter pattern in the present study was different from the results of Tai et al. indicating that the level of dry matter increased in sugar additive in maize silage compared to control group (Tai et al., 2003). Addition of formic acid decreased dry matter and pH value numerically; while increasing flieg point up to 10% compared to control group. The results showed parallelism with those of Rowghani et al. reporting that dry matter and pH value in silage treated with formic acid were lower than in the control group (Rowghani et al., 2009). This decrease can be attributed to the fermentation limitation by formic acid. Another study conducted with formic acid in grass silage showed (Baytok et al., 2005) an increase in dry matter concentration of grass silage when value of pH was reduced. The enhanced dry matter in grass silage treated with formic acid can probably be attributed to ensilage conditions and ensilage structure. This can be associated with the poorly packed silage material, air trapped in the silage, sludging and spoilage (Liu et al., 2018). When wilting time extended in silage, dry matter concentration increased and total protein content decreased. When dry matter concentration in the crop increased, microbial activity was inhibited and proteolysis was reduced during harvest and wilting. Thus, dry matter was negatively correlated to the amount of soluble NPN. Researchers

(Johansen et al., 2017) reported that while soluble N and NH3-N of total N decreased, dry matter increased the concentration in silage.

Based on the results, it was concluded that Lenox silage treated with molasses had an enhanced the quality compared to the other groups. Lenox silage treated with molasses was higher than the other groups in terms of dry matter, pH value and flieg point. On the other hand, the good quality point was obtained in molasses group. The DM of silage is the important for silage quality. Therefore, the forage such as hay and straw could be added to increase the DM of silage. It is required to conduct further studies on lenox silage in order to determine the effects of fermentation pattern and physically characteristics.

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