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Effects of Some Additives, Harvest Stage and Wilting on Quality Characteristics of Alfalfa Silage

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ABSTRACT: Although alfalfa is a good forage plant, it is one of the difficult to ensiled crops. The high protein content, low water soluble carbohydrate and dry matter content of alfalfa prevents healthy fermentation. Therefore, this study focused on the use of additives, arrangement of cutting time and wilting after cutting of alfalfa to make successful silage. The research was carried out at Ataturk University, Faculty of Agriculture in Erzurum, Turkey. It was arranged in a completely randomized experimental design with 3 replications. In the experiment, effects of 4 additives (non-additive, 5% molasses, 10% rolled barley and 5%molasses + 10% rolled barley), 2 cutting stages (early blooming and late blooming) and 2 wilting (unwilted and wilted) on alfalfa silage quality are analyzed. In study, dry matter content, crude protein content, neutral detergent fiber (NDF) content, relative feeding value (RFV), silage pH and physical quality score of 48 silage samples are determined.
In alfalfa silage, use of additives reduced the pH and NDF content, but increased dry matter content, RFV and silage quality score. These positive effects were more apparent with the use of molasses and rolled barley together. Delaying cutting time of alfalfa reduces crude protein content and increased NDF content. Moreover, in late cutting, fermentation was more successful and silage pH was decreased from 5.60 to 4.31. Making silage by wilting alfalfa increased dry matter content and thus had positive effect on fermentation and silage quality. According to the results of this study, in order to make successful silage from alfalfa, addition of molasses + rolled barley, cutting alfalfa in late flowering and wilting after cutting can be suggested.

Key Words: Alfalfa, silage, additive, growing stage, wilting

Bazı Katkı Maddeleri, Biçim Zamanı ve Soldurmanın Yonca Silajı Kalitesi Üzerine Etkileri

ÖZET: Yonca iyi bir kaba yem bitkisi olmasına rağmen silolanması zor bitkilerden birisidir. Yüksek protein oranı, düşük eriyebilir karbonhidrat ve kuru madde içeriği yoncanın sağlıklı fermantasyonunu engellemektedir. Bu nedenle bu araştırma yoncadan başarılı silaj yapabilmek için katkı maddeleri kullanımı, biçim zamanının ayarlanması ve biçimden sonra soldurulmasını konu almaktadır. Araştırma Erzurum Türkiye'de Atatürk Üniversitesi Ziraat Fakültesinde 2010 yılında tesadüf parselleri deneme desenine göre 3 tekrarlamalı olarak yürütülmüştür. Denemede 4 katkı (katkısız, %5 melas, %10 arpa kırması ve %5 melas + % 10arpa kırması), 2 biçim zamanı (çiçeklenme başlangıcı ve çiçeklenme sonu) ve 2 soldurma (soldurulmamış ve soldurulmuş) uygulamasının silaj kalitesi üzerine etkileri incelenmiştir. Araştırmada 48 adet silajın kuru madde oranı, ham protein oranı, NDF oranı, nispi yem değeri, pH'sı ve fiziksel kalite sınıfları belirlenmiştir.
Katkı maddesi kullanımı yonca silajında pH'yı ve NDF oranını düşürmüş, kuru madde oranını, nispi yem değerini ve silaj kalite sınıfını yükseltmiştir. Bu olumlu etkiler melas ve arpa kırmasının birlikte kullanılmasıyla daha belirgin olmuştur. Yoncanın biçim zamanının geciktirilmesi ham protein oranını düşürmüş ve NDF oranını yükseltmiştir. Buna karşılık geç biçimlerde fermantasyon daha başarılı olmuş ve silaj pH'sı 5.60'tan 4.31'e düşmüştür. Yoncanın soldurularak silaj yapılması kuru madde oranını artırarak fermantasyona ve silaj kalitesine olumlu etki yapmıştır. Bu çalışmanın sonuçlarına göre yoncadan daha başarılı silaj yapabilmek için melas + arpa kırması katkısı yapmak, yoncayı geciktirerek biçmek veya biçtikten sonra soldurmak önerilebilir.

Anahtar Kelimeler: Yonca, silaj, katkı, biçim zamanı, soldurma

INTRODUCTION

Alfalfa that is mostly used as a hay plant, has a wide cultivation area in the Eastern Anatolia Region, Turkey. However, important quality losses may have occurred due to mold in plants in rainy and humid periods and loss of leaves in drying periods in alfalfa production in this region. Therefore, farmers began to consider using alfalfa as silage in addition to using it as hay to decrease the loss in quality characteristics.

Similar to the other legumes, it is highly difficult to obtain qualified silage from alfalfa (Albrecht and Beauchemin, 2003). For this purpose, different additive materials, mostly rolled barley, which is easy to find, is used (Dumlu, 2007). Dumlu and Tan (2009) stated that adding 5% rolled barley is not enough for a successful fermentation in alfalfa. Whereas, Ciftci et al. (2006) found that adding 1% sugar, 10% rolled barley and 10% apple to alfalfa silage increases fermentation. In order to prevent unwanted bacteria occurrence, adding salt (Dumlu, 2007) and in order to make fast fermentation, adding molasses (Kızılşimşek et al., 2011) is suggested. Fermentation problems of legume silages can solve with make mixture grasses (Balabanlı et al., 2010).

Another problem is that the dry matter content in alfalfa is insufficient for successful silage (Dumlu, 2007) and this situation may cause fermentation difficulties and losses with leakage in silage material (Kılıç, 2010). Adjustments in the harvest stage or wilting after cutting may be an alternative to solve

this problem. It is suggested that alfalfa should be harvested at the beginning of flowering to produce hay (Tan and Serin, 2008). The dry matter content of alfalfa mowed at the beginning of flowering is about 25% (Canbolat et al., 2010). Fermentation becomes difficult and losses increase with leakage in this material (Kılıç, 2010). Delaying stage cutting can increase dry matter and carbohydrate in the plant. Yari et al. (2012) studying on different growing stages in alfalfa (beginning of budding - beginning of flowering) determined that dry matter content varies between 21% and 32%. However, alfalfa's fiber content increases and the crude protein content decreases in parallel with advanced of the growth stage. Therefore, it is difficult to determine the cutting stage of alfalfa for silage. One of the easiest ways of increasing dry matter content of alfalfa is wilting after cutting. Wilting cause increases in the dry matter and carbohydrate content and decreases transportation losses. Basmacıoğlu and Ergül (2002) stated that wilting is beneficial to forage crops whose water soluble carbohydrate content insufficient like alfalfa. Rangrab et al. (2000) found that the dry matter contents in unwilted and wilted alfalfa silages for 24 hours are 26.3%and 44.1%, respectively. Wilting of legumes cause decreases the buffer capacity that prevents fermentation in silage (Cavallarin et al., 2005).

Consequently, additives, harvest stage (Tan et al., 2014) and wilting (Cavallarin et al., 2005; Kung et al., 2010) are important factors in order to make successful silage. Therefore, the aim of this research was to determine effects of some additives, harvest stage and wilting on quality characteristics of alfalfa silage.

MATERIAL AND METHOD

The research was conducted under laboratory conditions at the Department of Field Crops, Faculty of Agriculture, Atatürk University,in 2010. Alfalfa (*Medicago sativa* L.) samples that are first growing taken from fields of the faculty Farm. In order to make silage, alfalfa was clipped at two different growing stages (early blooming and late blooming). Unwilted silages are made without delay immediately after the cut of alfalfa. Wilting was done in the open air on a sunny field conditions for 12 hours after clipping. Unwilted and wilted plant samples were chopped with a laboratory type silage machine and silages were made in glass jars of 2.5 kg. Silages were made as pure or mixed with additives (5% molasses, 10% rolled barley, 5% molasses + 10% rolled barley). The research was arranged in completely randomized experimental design with 3 replications. Totally 48 silages were examined in the experiment (4 additive applications x 2 wilting applications x 2 cutting stages x 3 repetitions).

Each silage was opened to analyze for quality properties after being done for 60 days and then taken samples were oven dried at 105 ^{0}C for 48 hours to find the dry matter content (Ref.). The Kjeldahl method and a Vapodest 45 with Titration Rapid Kjeldahl Distillation Unit (Gerhardt, Konigswinter, Germany) were used to determine total N (Bremner, 1996) in silages. NDF and pH measurements of silages were determined according to Akyıldız (1986) and Kılıç (2010). Relative Feed Value (RFV) was calculated from feed analysis values (Rohweder et al., 1978).The formula for calculating RFV is: RFV=(DDM x DMI)/1.29, where Digestible Dry Matter (DDM (%) = 88.9 -0.779ADF (% of DM), Dry Matter Intake (DMI) =120/NDF. Physical properties of silages such as color (according to 0, 1 and 2 quality scores), structure (according to 0, 1, 2 and 4 quality scores) and smell (according to 0, 2, 4, 8 and 14 quality scores) were found by the method of Kılıç (2010) and Kaçar and İnal (2008). As a very good total score 18-20, good total score 14-17, middle total score 10-13, utility total score 5-9 and low total score 0-4 divided into in this research.

The results were statistically evaluated using MSTAT-C procedures and mean separations were made on the basis of Least Significant Differences (LSD).

RESULTS AND DISCUSSION

Additives like molasses and rolled barley increased the dry matter content of alfalfa silages (Table 1). In the control, while the dry matter content was 28.64%, it was 34.45%, 36.57% and 38.62%, in molasses, rolled barley and molasses + rolled barley additions, respectively. Dry matter contents of both materials used as additives were higher than alfalfa silage. Akyıldız (1986) explained that dry matter content in barley and molasses were 77%, and 86%. This is why, adding additives increased dry matter content in alfalfa silage. Making silage without waiting after harvesting caused alfalfa to have a 31.06% dry matter content. However, after 12 hours of wilting, the dry matter content increased significantly and became 38.08%. Increase in dry matter after wilting was an expected result and the same result was obtained in other studies (Cavallarin et al., 2005; Kung et al., 2010). Delaying the cutting stage also caused an increase in the dry matter content of alfalfa. In cutting at the beginning of flowering, the dry matter content was 28.07% while it was 41.07% at the end of flowering. In parallel

with advanced growing stage of plants, structural materials increases and water content decreases (Yolcu et al., 2006). Double and triple interactions of factors were found to be effective on the dry matter contents of silages. This situation shows that common effect of wilting and arrangement of cutting stage besides additive is significant (Figure 1). The dry matter contents of wilted silage with molasses + rolled barley, late cut silage with molasses + rolled barley and late cut and wilted silage were higher. When considering the three factors the highest dry matter content was found late cut and wilted silage with molasses + rolled barley.

Table 1. Effects of some additives, harvest stages and wilting on the dry matter content, neutral detergent fiber and relative feed value of alfalfa silage[1]

Additives	**Dry Matter (%)**	**NDF (%)**	**RFV**
Control	28.64 D	34.49 A	132.1 B
Molasses	34.45 C	31.49 B	150.1 AB
Rolled Barley	36.57 B	27.64 C	158.7 A
Molasses + R. Barley	38.62 A	29.00 C	161.8 A
Wilting			
Unwilted	31.06 B	31.00	152.8
Wilted	38.08 A	31.22	148.6
Cutting Stage			
Early Bloom	28.07 B	25.09 B	176.1 A
Late Bloom	41.07 A	36.22 A	125.3 B
Mean	34.57	30.66	150.7
***F*-test**			
Additives	**	**	**
Wilting	**	ns	ns
Additives x Wilting	**	ns	ns
Cutting Stage	**	**	**
Additives x Cutting Stage	**	*	ns
Wilting x Cutting Stage	**	*	ns
Additives x Wilting x C. Stage	*	ns	ns

[1]Values followed by different letters in a column shows significantly differences
ns: nonsignificant, *Significant at 5% level, **Significant at 1% level.

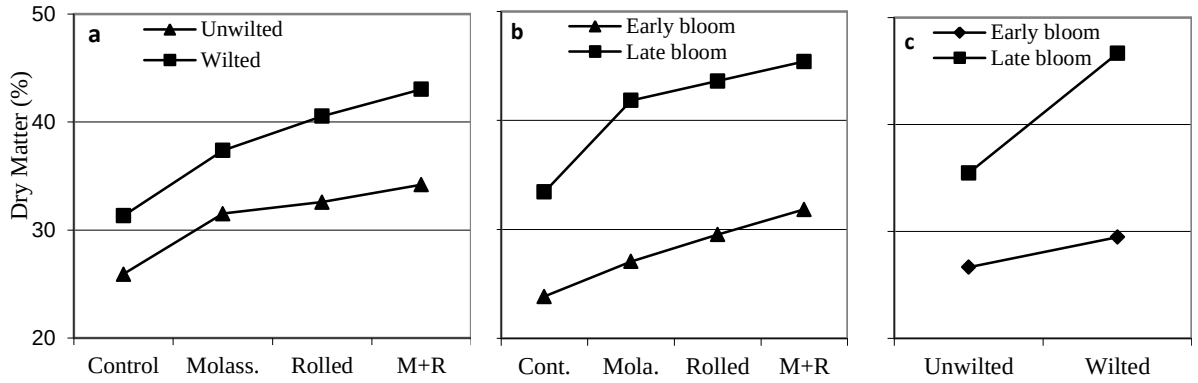

Figure 1. Interactions which affected dry matter content of alfalfa silage (a. additive x wilting, b. additive x cutting stage, c. wilting x cutting stage)

Additives and the cutting stages applied in the research significantly affected NDF contents in alfalfa silage (Table 1). In silages, without using additives, the NDF content was high (34.49%) although it significantly decreased with adding molasses and rolled barley (respectively 31.49% and 27.64%). Molasses is a material that doesn't contain fiber and although there are fibroid materials on skin of rolled barley, the ratio is still low. That is why, application of additives decreases NDF contents of silages. Can et al. (2003) and Dumlu and Tan (2009) found similar results. NDF content of alfalfa silage at the beginning of flowering was 25.09% and it increased to 36.22% at the end of flowering stages. . As plant growth advanced, increase of NDF content is an expected resutlari et al. (2012) stated that increase in alfalfa's NDF content especially quick during the generative period. In the study, it was found that additive + cutting stage and wilting + cutting stage common effects have a significant effect on the NDF content (Figure 2). The NDF contents of later cut silage without additives and later cut and wilted silage were higher.

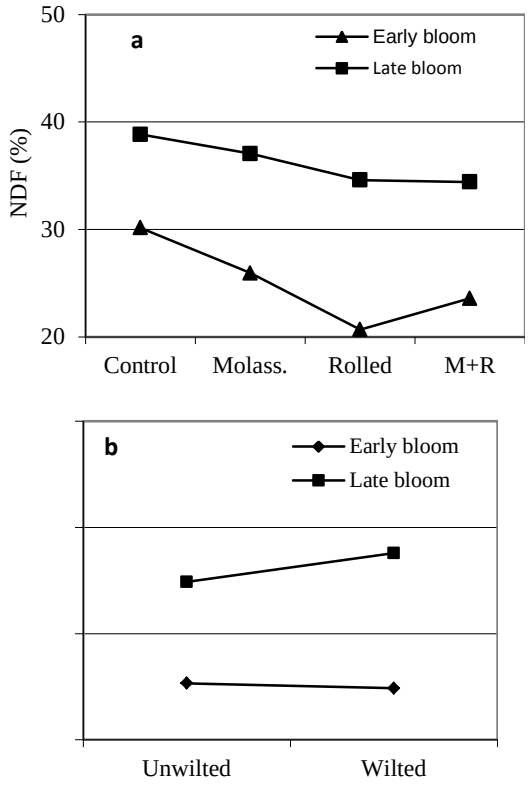

Figure 2. Interactions that affected NDF content of alfalfa silage (a. additive x cutting stage, b. wilting x cutting stage).It was seen that the additive and cutting stage had important effects on the Relative Feeding Value (RFV) of silages while wilting and interactions' effects were found to be insignificant (Table 1). The RFV of non-additive silages was found to be 132.1. RFV at the applications of molasses, rolled barley and molasses + rolled barley were found to be 150.1, 158.7 and 161.8, with a significant increase. Both molasses and rolled barley are additives that have high nutritional value. Addition of these materials increases RFV of silages. Canbolat et al. (2010) found that adding grape pulp increases relative feeding value of alfalfa silage. Delaying of cutting stage had a negative effect on the relative feeding value. RFV decreases because of leaf ratio, protein content and similar nutrients decrease in plants with late cutting stage (Yari et al., 2012).

It was found that additives and wilting had no significant effects on the crude protein content of alfalfa silage, although the cutting stage had very significant effects (Table 2). The crude protein content in alfalfa silage that was 17.74% in cut at early bloom stage and it significantly decreased to 13.12% at late bloom stage. Researchers like Yolcu et al. (2006) and Yari et al. (2012) also determined decrease in crude protein content in parallel with delaying in growth stage of alfalfa.

Adding additives to alfalfa significantly decreased the silage pH value (Table 2). The silage pH value of non-additive silages is 5.85. pH values were found 5.25, 4.62 and 4.10 in molasses, rolled barley and molasses + molasses applications, respectively. Additives like molasses make ease fermentation and decrease the pH value of silages, because they have high soluble carbohydrate concentration (Umana et al., 1991). When molasses and rolled barley were applied together, they became more effective to decrease the pH of alfalfa silage in this study. Researchers like Ciftci et al. (2006) and Kızılşimşek et al. (2011) also determined that when proper additive is used, the pH value of alfalfa silage decreases. Other applications that decrease pH value of silages are wilting and delaying the cutting stage.

Table 2. Effects of some additives, harvest stages and wilting on crude protein, pH and physical evaluation of alfalfa silage[1]

Additives	**Crude Protein (%)**	**Silage pH**	**Physical Evaluation**
Control	16.18	5.85 A	4- Low
Molasses	15.16	5.25 AB	5- Utility
Rolled Barley	15.51	4.62 BC	6- Utility
Molasses + R. Barley	14.90	4.10 C	11- Middle
Wilting			
Unwilted	15.74	5.12 A	4- Low
Wilted	15.11	4.80 B	10- Middle
Cutting Stage			
Early Bloom	17.74 A	5.60 A	3- Low
Late Bloom	13.12 B	4.31 B	10- Middle
Mean	15.43	4.96	
***F*-test**			
Additives	ns	**	
Wilting	ns	**	
Additives x Wilting	ns	ns	
Cutting Stage	**	**	
Additives x Cutting Stage	ns	ns	
Wilting x Cutting Stage	ns	ns	
Additives x Wilting x C. Stage	ns	ns	

[1]Values followed by different letters in a column shows significantly differences
ns: nonsignificant, **Significant at 1% level.

Other applications that decrease pH value of silages are wilting and delaying the cutting stage. The silage pH decreased from 5.12 to 4.80 with wilting; it decreased from 5.60 to 4.31 with delaying the cutting stage. Owens et al. (1999) determined that wilting decreases silage pH at alfalfa and red clover. Because, dry matter content increases and buffer capacity that prevent fermentation decreases with wilting (Cavallarin et al., 2005).

According to physical evaluation results, alfalfa silages that were done without additives were in the low score. Conversely, when molasses or barley was added, the silage score belonged to the utility level, when both molasses and barley were added, it belonged to middle level. Besides, the fact that this situation is not enough, it shows that additives that are used as carbohydrate source increase silage quality. Silages that are obtained by cutting at the early stage and unwilting determined belong to low quality score. In contrast to this, wilting and delaying cutting stage increased the silage quality score to the middle level (Table 2).

In this study, it was determined that ensiling alfalfa in the early flowering period, without wilting and not using any additive material did not give successful results, because alfalfa's water soluble carbohydrates and dry matter content were low. In contrast to this, applications of carbohydrate additives such as molasses and rolled barley increased the silage dry matter content, relative feeding value and silage quality score, while they decreased the silage pH. Application of these two additives gave better results. By wilting alfalfa after cutting, the dry matter content increased from %31.06 to %38.08. This situation facilitated fermentation, decreased the silage pH and increased the silage quality score. Another application that increased the dry matter content was delaying cutting to the late blooming stage. In this application, although the crude protein content decreased, silage quality was positively affected.

According to the results of this study, in order to obtain better fermentation in alfalfa silage the use of molasses + rolled barley as additives, cutting alfalfa at the late bloom and wilting after cutting can be suggested. However, it is helpful to study the different applications in order to produce more successful silage.

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