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Effects of whipped cream addition on fermentation quality and relative feed value of alfalfa silage

Efeitos da adição de creme de leite na qualidade de fermentação e valor alimentar relativo da silagem de alfafa

Sibel Soycan Önenç[1]*; Damla Yayla[2]; Merve İrez Şerbetçi[2]

Highlights

The addition of whipped cream increased the lactic acid bacteria counts of silages.
The addition of whipped cream decreased the proteolysis in the silages.
The addition of whipped cream increased the relative feed values of silages.

Abstract

This study aims to determine the effects of whipped cream addition to alfalfa on fermentation quality and relative feed value (RFV). Alfalfa harvested at the beginning of blooming (5th cutting) was withered under laboratory conditions for 48 hours. In the study, 4 different levels of whipped cream were used, and no additives were added to the control group. A total of 20 packages of silage were left for fermentation in a closed storage (16±2 °C) for 90 days, 4 repetitions for each group. As a results of this study dry matter (DM) contents of silages increased due to the increase in the level of whipped cream addition. pH of silages was decreased significantly in the groups that participated in 20 ve 30 g kg^{-1} of whipped cream compared to the control ($P < 0.01$). In these groups, crude protein (CP) amount was higher ($P < 0,01$), and ammonia nitrogen (NH_3-N) was lower ($P < 0.01$) than control and other whipped cream groups. The water soluble carbohydrate (WSC) contents increased in parallel with the increase in the whipped cream level added to the alfalfa, and lactic acid (LA), as for that, was determined to be the highest (80.40 g kg^{-1} DM) level in the group with 30 g kg^{-1} whipped cream. In the same group, neutral detergent fiber (NDF: 383.1 g kg^{-1} DM) and acid detergent fiber (ADF: 245.4 g kg^{-1} DM) were observed to be at the lowest level, yeast numbers decreased similarly, enterobacter and mold did not develop, and RFV increased. According to the results obtained from the study, it was demonstrated that by adding 20 or 30 mg kg^{-1} of whipped cream to alfalfa, quality alfalfa silage could be obtained, and the waste whipped cream can be used as a silage additive and can be recycled to the economy.

Key words: Alfalfa. Fermentation quality. Silage. Whipped cream.

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Resumo

Este estudo teve como objetivo determinar os efeitos da adição de creme de leite à alfafa sobre a qualidade da fermentação e valor relativo da ração (VRR). A alfafa colhida no início da floração (5º corte) foi seca em laboratório por 48 horas. No estudo, 4 níveis diferentes de creme de leite foram usados e nenhum aditivo foi adicionado ao grupo controle. No total, 20 embalagens de silagens foram deixadas para fermentação em local fechado (16 ± 2 ° C) por 90 dias, sendo 4 repetições para cada grupo.Os teores de matéria seca (MS) das silagens aumentaram devido ao aumento do nível de adição de creme de leite. O pH das silagens diminuiu significativamente nos grupos que participaram de 20 a 30 g kg^{-1} de creme de leite em relação ao controle (P < 0,01).Nestes grupos, o teor de proteína bruta (PB) foi maior (P < 0,01) e o nitrogênio amoniacal (NH_3-N) foi menor (P < 0,01) do que o controle e os demais grupos com creme de leite. Os teores de carboidratos solúveis em água (CSA) aumentaram paralelamente ao aumento do teor de creme de leite adicionado à alfafa, e o ácido lático (AL), nesse sentido, foi determinado como o maior nível (80,40 g kg^{-1} MS) no grupo com 30 g kg^{-1} de creme.No mesmo grupo, a fibra em detergente neutro (FDN: 383.1 g kg^{-1} DM) e a fibra em detergente ácido (FDA: 245.4 g kg^{-1} DM) foram observados no nível mais baixo. O número de leveduras diminuiu de forma semelhante, enterobactéria e fungos não se desenvolveram e a VRR aumentou.De acordo com os resultados obtidos no estudo, foi demonstrado que adicionando 20 ou 30 mg kg^{-1} de creme de leite à alfafa, pode-se obter silagem de alfafa de qualidade, e o creme de leite residual pode ser utilizado como aditivo de silagem e pode ser reciclado para a economia.

Palavras-chave: Alfafa. Creme de leite. Qualidade da fermentação. Silagem.

Introduction

Water soluble carbohydrate content of legume forage crops such as alfalfa and clover is much lower than that of sugar beet leaves, corn, and other poaceae forage crops. It is reported that the lowest sugar level of the feed material to be silaged varies according to the DM content, and the average sugar content is 4-5% in DM, 8-10% in corn, and 10-20% in other poaceae feed plants other than maize (Kurtoğlu, 2011).

It is not easy to make good quality silage from legume forage plants such as alfalfa due to its high buffer capacity (Bc) and low WSC content (Özaslan, 2016). Because more acid formation is required for the pH of the environment to decrease. However, since withering up to 30-35% DM increases the sugar content in cell water and decreases the buffer capacity, it is beneficial to start such a process of young plants, which are naturally rich in water and high in protein. It may also be possible to mix sugar or molasses into the feed to be silaged (Kurtoğlu, 2011; Besharatı, Palangı, Nekoo, & Ayaşan, 2021). In our country, many kinds of research have been conducted on the production of alfalfa silage by adding molasses, molasses sugar beet pulp, and barley (Dumlu Gül, Tan, Fayetörbay Kaynar, & Kharazmi, 2015; Şakalar, 2015; Bostan, 2016; Malhatun-Çotuk & Soycan-Önenç, 2017).

Nevertheless, some of the sugar factories in Turkey were transferred to the private sector through privatization tenders held in 2018 (Türkşeker Sector Report, 2020). A decrease in beet production and processing and a parallel decrease in molasses production are expected to parallel privatization. In addition to this, decreases occur in global grain production with global climate changes. Besides, sustainable waste management

was brought to the fore in National Waste Management. Action Plan 2023 to prevent the rapid consumption of natural resources. Sustainable waste management requires waste prevention, reuse, recycling and recovery, and moving up the waste hierarchy (Environment & Urban Ministry, 2017).

One of the largest industries in the world is the food industry, and the Marmara Region is one of the regions where it is concentrated in our country. The food industry generates significant waste during the production process (spillage, runny liquid, crumbs) and transportation storage (air contact with rupture-puncture of the packaging). This situation causes considerable economic losses for food production companies. Recycling and recovery will be possible by utilizing these foods in livestock enterprises within sustainable waste management. After all, fewer new additives may be needed to produce silage, which is an essential roughage in ruminant nutrition.

The purpose of the research planned in the light of this information is to determine the effects of food industry waste (expired) powdered whipped cream on fermentation quality and relative feed value of alfalfa silage.

Materials and Methods

The study material consisted of alfalfa harvested at the beginning of blooming (5th cutting) in the last week of October 2020 and expired powdered whipped cream. The nutrient contents before ensilage are given in Table 1.

Table 1
Chemical component of alfalfa and whipped cream before ensilage

Name of the component	Alfalfa	Whipped cream
Dry matter, g kg^{-1} DM	284.9	986.3
Organic matter, g kg^{-1} DM	885.7	983.2
Crude ash, g kg^{-1} DM	114.3	16.8
Crude protein, g kg^{-1} DM	210.6	51.2
NDF, g kg^{-1} DM	419.2	-
ADF, g kg^{-1} DM	273.4	-
ADL, g kg^{-1} DM	104.1	-
Hemicellulose, g kg^{-1} DM	145.8	-
Cellulose, g kg^{-1} DM	169.3	-
pH	6.0	-
WSC, g kg^{-1} DM	78	212.5
Bc, Meq NaOH g kg^{-1} DM	720	-
DDM, %	67.8	-
DMI, %	2.86	-
RFV	149.98	-

NDF-Neutral detergent fiber, ADF-Acid detergent fiber, ADL-Acid detergent lignin, WSC-Water soluble carbohydrates, Bc-Buffer capacity, DDM-Digestible dry matter, DMI-Dry matter intake, RFV-Relative feed value.

Alfalfa was harvested at the beginning of blooming and withered in laboratory conditions for 48 hours. The whipped cream was added after being crushed in the silage machine in approximately 1.5-2.0 cm. No additives were added to the control group (CON). Whipped cream groups were formed by adding (WC2) 20 g kg^{-1} alfalfa, (WC3) 30 g kg^{-1} alfalfa, (WC4) 40 g kg^{-1} alfalfa, and (WC5) 50 g kg^{-1} alfalfa. The whipped cream was added to approximately 2 kg of alfalfa and mixed, and then it was placed in plastic bags, and the air inside was removed by vacuum. The bags were covered with the stretch film 10-12 times and finally wrapped with a layer of tape. A total of 20 packages of silage were left for fermentation in a closed storage (16±2 °C) for 90 days, 4 repetitions for each group.

pH values of silage opened by spreading on a flat surface at the end of the silage period (90^{th} day) were determined with a digital pH meter, buffer capacity according to Playne and McDonald (1966), by LA spectrophotometric method (Barker & Summerson, 1941). Total points (DLG) were determined and Flieg points were calculated in silages according to Kılıç (1986):

Flieg point= 220 + (2 x DM % -15) - 40 x pH

Ammonia nitrogen and WSC contents of silages were carried out according to Minister of Agriculture, Fisheries and Food (1986). Lactic acid bacteria (LAB), yeast, and mold analyzes were determined by the method developed by Seale et al. (1990), and total mesophilic aerobic bacteria counts (TMAB) were determined according to International Standard Organization [ISO] 4833, (2014). Statistical analysis was performed after taking the logarithms of the determined LAB, yeast, and mold numbers "colony-forming unit" (cfu/g) values according to the base 10. The DM was determined by drying the samples at 105 °C for 16 h (Association of Official Analytical Chemists [AOAC], 1990). Organic matter (OM), CP and crude ash (CA) contents of feed samples were determined by AOAC (1990). Contents of NDF, which forms the cell wall components of feeds, ADF and acid detergent insoluble lignin (ADL), as for that, was performed according to the methods reported by Van Soest, Robertson and Lewis (1991). Hemicellulose and cellulose were found by calculation (Close & Menke, 1986). Equations reported by Van Dyke and Anderson (2000) were used to determine the RFV of silages. For this purpose, firstly digestible dry matter (DDM), secondly dry matter intake (DMI) was estimated and finally RFV was predicted.

DDM, % of DM = 88.9 - (0.779 x % ADF), DMI (as a % body weight) = 120 / % NDF

RFV = %, DDM x % DMI x 0.775.

In vitro metabolic energy (ME) contents were calculated according to NDF, ADF, ADL, and DDM using the equations given below.

ME_{NDF},ME, kcal/kg KM=3381.9-19.98 x NDF* (Kirchgessner, Kellner, Roth, & Ranfft, 1977)

**ME_{ADF}, ME, MJ/kg KM= 14.70-0.150 x ADF* (Kirchgessner & Kellner, 1981)

ME_{ADL}, ME, kcal/kg KM=2764.4-102.73 x ADL* (Kirchgessner et al., 1977)

**ME_{DDM}, MJ/kg KM =(0.17x DDM %)-2.0 (Belyea, Steevens, Garner, Whittier, & Sewell, 1993)

(* NDF, ADF, and ADL values are taken as %).

** ME contents were translated into kilocalories

The data obtained at the end of the research were evaluated by performing

variance analysis in the SPSS v18 (Statistical Package for the Social Sciences [SPSS], 2009) package program. Duncan multiple comparison tests were used to comparing group averages (Efe, Bek, & Şahin, 2000).

Results and Discussion

According to the physical evaluation conducted, the addition of whipped cream to alfalfa affected the smell positively. There was no negativity in the structure, and the addition of whipped cream affected the color positively. Considering the quality classes in each of the five groups, it is seen in Table 2 that the CON group is satisfactory, and the groups with the addition of whipped cream are good. Flieg scores were 94.73, 113.57, 127.95, 98.59, and 101.87 in CON and whipped cream groups, respectively (P <0.01).

Table 2
The effects of different whipped cream levels on silage qualities (n=4)

Treatments	Smell	Structure	Colours	DLG point	Quality	Flieg Point	Quality
CON	8.0	4.0	1.0	13	Moderate	94.73±2.25^{c}	Excellent
WC2	14.0	4.0	2.0	20	Excellent	113.57±1.30^{b}	Excellent
WC3	14.0	4.0	2.0	20	Excellent	127.95±2.47^{a}	Excellent
WC4	14.0	4.0	1.0	19	Excellent	98.59±1.12^{c}	Excellent
WC5	14.0	4.0	1.0	19	Excellent	101.87±0.93^{c}	Excellent
P-value						<0.001	

CON-Control, WC2-Whipped cream 20 g kg^{-1}, WC3-Whipped cream 30 g kg^{-1}, WC4-Whipped cream 40 g kg^{-1}, WC5-Whipped cream 50 g kg^{-1}, ± SEM-Standart error of means, $^{a-d}$-Means with different letters in the same column are statistically significant (P<0.01).

According to physical evaluation, the addition of whipped cream has resulted in silages with green color, pleasant slightly acidic odor, with intact stem and leaf integrity. The DLG score of the control group was similar to the results of the studies in which the Malhatun-Çotuk and Soycan-Önenç (2017) added bran and pudding, and Yayla and Soycan-Önenç (2021) added jam and jam particles. Flieg scores were found to be higher in the whipped cream groups than those of Malhatun-Çotuk and Soycan-Önenç (2017), Yayla and Soycan-Önenç (2021), except for the 100 mg liquid jam group, but were evaluated within the same quality class.

The addition of whipped cream to alfalfa positively affected the DM content of silages, and DM increased depending on the dose increase (Table 3).

Table 3
Fermentation quality of alfalfa silages

Treatments	DM g kg^{-1} DM	pH	CA g kg^{-1} DM	CP g kg^{-1} DM	WSC (g kg^{-1} DM)	LA (g kg^{-1} DM)	NH3-N (g kg^{-1} TN)	WL g kg^{-1}
CON	248.6±0.03^{d}	4.00±0.01^{a}	125.5±0.01^{a}	181.7±0.01^{c}	57.19±0.10^{e}	40.60±0.10^{e}	9.91±0.01^{b}	10.4±0.01^{a}
WC2	269.5± 0.04^{c}	3.63±0.06^{b}	118.2±0.05^{b}	189.1±0.01^{a}	82.76±0.07^{d}	48.59±0.08^{d}	6.95±0.09^{d}	9.9±0.01^{ab}
WC3	274.7±0.09^{b}	3.30±0.06^{c}	114.8±0.02^{c}	186.9±0.01^{b}	86.04±0.05^{c}	80.40±0.09^{a}	7.84±0.08^{c}	8.6±0.03^{c}
WC4	275.3±0.08^{b}	4.04±0.03^{a}	110.9±0.03^{d}	171.5±0.02^{d}	88.28±0.08^{b}	66.90±0.07^{b}	9.58±0.08^{b}	9.7±0.01^{b}
WC5	289.7±0.08^{a}	4.03±0.03^{a}	105.3±0.05^{e}	168.1±0.05^{e}	119.40±0.08^{a}	57.15±0.08^{c}	15.32±0.10^{a}	9.9±0.02^{ab}
P-value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

CON-Control, WC2-Whipped cream 20 g kg^{-1}, WC3-Whipped cream 30 g kg^{-1}, WC4-Whipped cream 40 g kg^{-1}, WC5-Whipped cream 50 g kg^{-1}, DM-Dry matter, CA-Crude ash, CP-Crude protein, WSC-Water soluble carbohydrates, LA-Lactic acid, NH_3-N-Ammonia nitrogen, TN-Total nitrogen,WL-Weigth loss, ± SEM-Standart error of means, $^{a-d}$-Means with different letters in the same column are statistically significant (P<0.01).

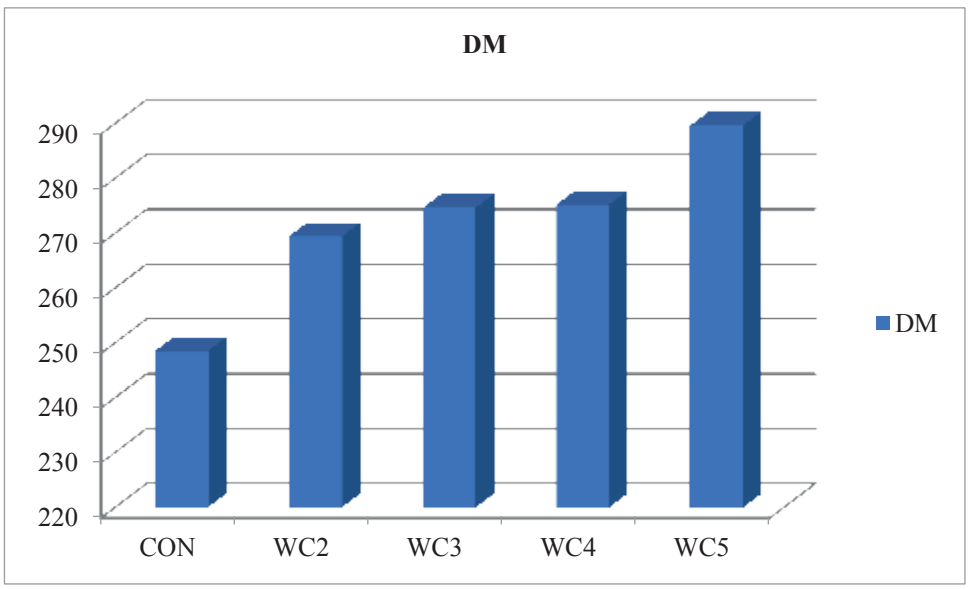

Figure 1. Change in dry matter of alfalfa silages CON- Control, WC2-Whipped cream 20 g kg^{-1}, WC3-Whipped cream 30 g kg^{-1}, WC4-Whipped cream 40 g kg^{-1}, WC5-Whipped cream 50 g kg^{-1}, DM: Dry matter,g kg^{-1}.

The lowest DM content was 248.6 g kg^{-1} DM in the control group (Figure 1), and the highest was 289.7 g kg^{-1} DM in the WC5 group (P<0.01). In this study found that DM contents increased due to the increase in the additive ratio of whipped cream added to alfalfa. Similarly, it was reported that the DM content of alfalfa silages increased depending on the additive ratio of molasses dried beet pulp (Şakalar, 2015). In another study (Malhatun-Çotuk & Soycan-Önenç, 2017), bran and pudding to alfalfa increased the DM of silages. The increase in DM of silages was due to the high DM (986.3 g kg^{-1} DM) content of whipped cream.

The pH of the silages decreased significantly in the WC2 and WC3 groups (Figure 2) compared to the CON (P<0.01). In the study conducted, it was found that the pH content of silages varied between 3.30-4.04. For good quality silages, the pH is desired to be between 3.5-4.0 (Kurtoğlu, 2011).

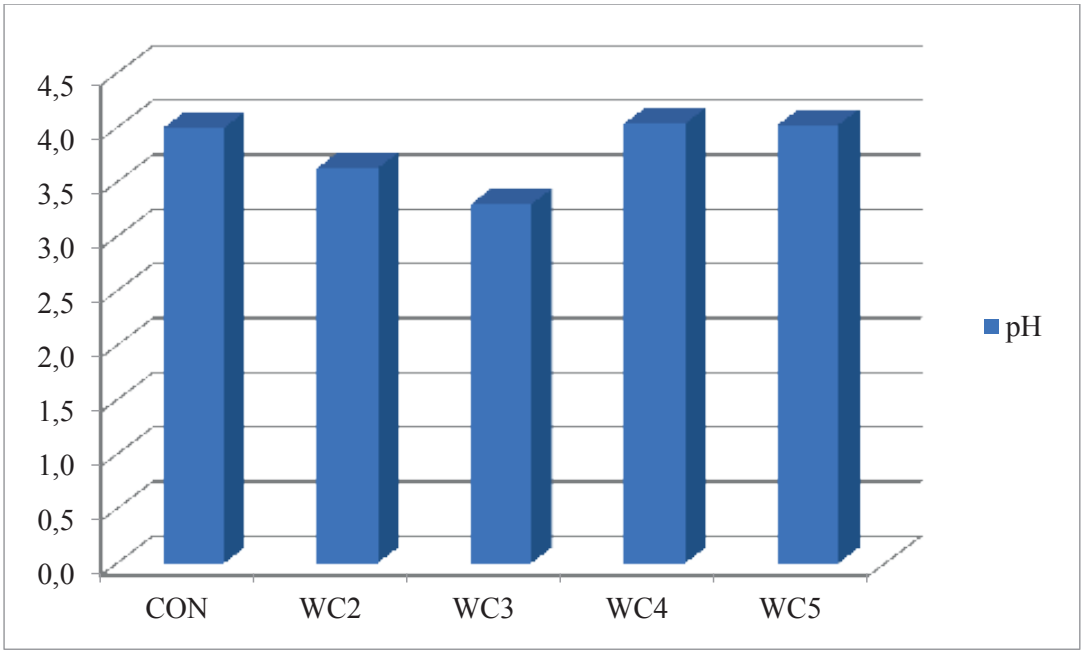

Figure 2. Change in pH of alfalfa silages, CON-Control, WC2-Whipped cream 20 g kg^{-1}, WC3-Whipped cream 30 g kg^{-1},
WC4-Whipped cream 40 g kg^{-1}, WC5-Whipped cream 50 g kg^{-1}.

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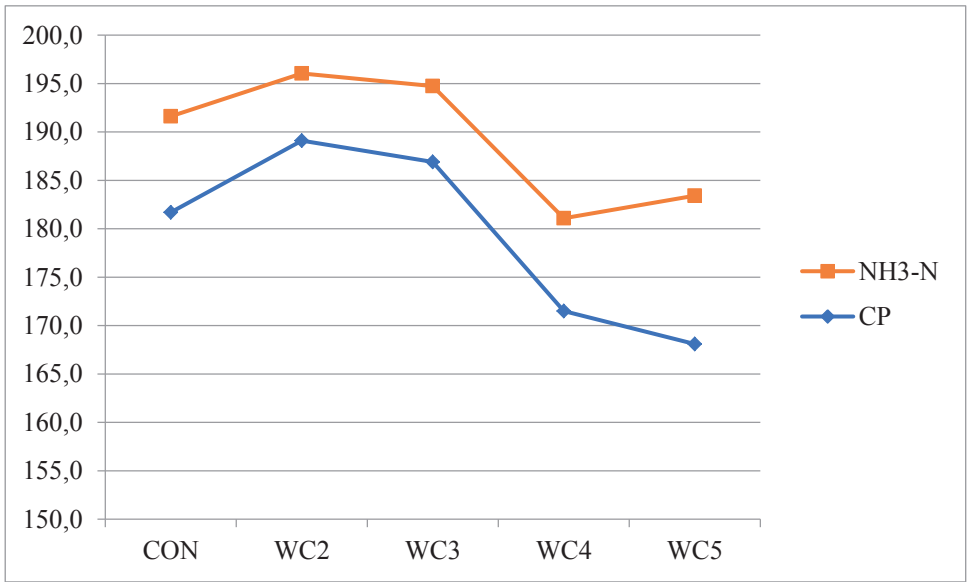

Figure 3. Change in crude protein and NH_3-N of alfalfa silages, CON- Control, WC2-Whipped cream 20 g kg^{-1}, WC3-Whipped cream 30 g kg^{-1}, WC4-Whipped cream 40 g kg^{-1}, WC5-Whipped cream 50 g kg^{-1}.

The addition of whipped cream to alfalfa significantly increased the WSC content compared to the control group ($P<0.01$). WSC contents increased in parallel with the increase in the amount of whipped cream added to alfalfa, LA, as for that (Figure 4), was determined in the highest WC3 (80.40 g kg^{-1} DM).

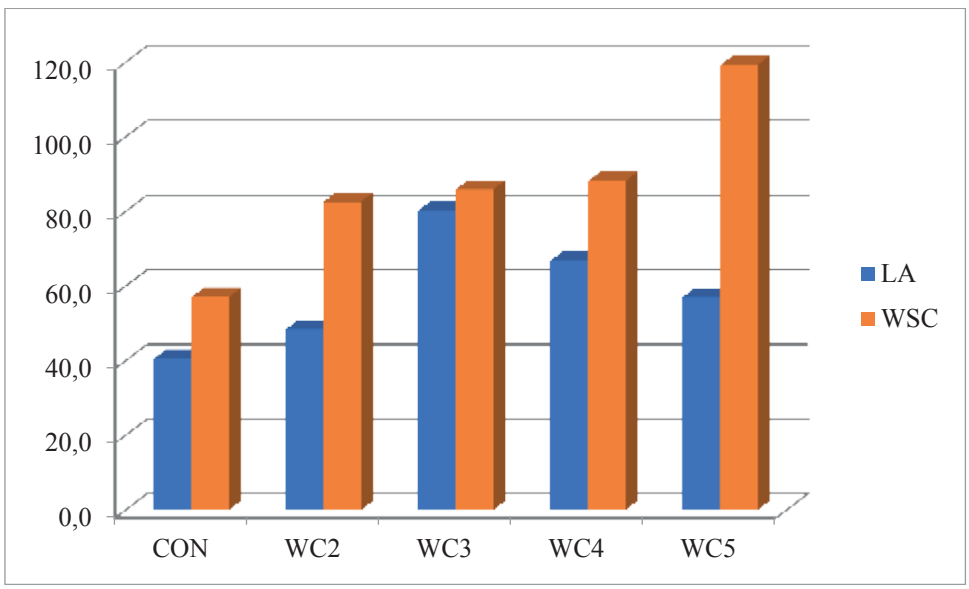

Figure 4. Change in WSC and LA of alfalfa silages, CON- Control, WC2-Whipped cream 20 g kg^{-1}, WC3-Whipped cream 30 g kg^{-1}, WC4-Whipped cream 40 g kg^{-1}, WC5-Whipped cream 50 g kg^{-1}, WSC-Water soluble carbohydrates, LA-Lactic acid.

In addition to the increase in the WSC content of the silaged green feed, the acidic environment required for good silage must be created. Therefore, low pH is expected in the 20, and 30 g kg^{-1} (WC2 and WC3) whipped cream groups. With the decrease of acidity in silage, the conversion efficiency of WSC to LA also increases (Özaslan, 2016). As shown in Figure 4, the conversion of WSC to LA increased with the decrease in pH in the groups. Nevertheless, although LAB and LA were higher than the control group in the WC4 and WC5 groups, the high level of WSC (WC4:88.28 WC5: 119.4 g kg^{-1} DM) was determined to increase the whipped cream level in these groups caused the WSC content to be very high. This situation can be explained by the fact that the amount of WSC in the environment exceeds the level that LAB can use. Similar results were reported in studies conducted with alfalfa pudding (Malhatun-Çotuk & Soycan-Önenç, 2017) and the addition of jam (Yayla & Soycan Önenç, 2021). Molasses as a source of fermentable sugar is known to promote the growth of LAB to improve the fermentation quality of silage (Hashemzadeh-Cigari et al., 2014; Liu et al., 2020). In this research, whipped cream effected like molasses and stimulated the growth of LAB. Thus, it can be interpreted that microorganisms which find sufficient amount of WSC in the environment develop better and provide high quality silage and decrease WL. As seen in Table 3, the fact that the addition of whipped cream was effective in preventing weight loss (WL), especially in the WC3 group ($P<0.01$), supports this.

As can be seen from Table 4, the addition of whipped cream to alfalfa reduced NDF, ADF, and ADL, which are cell wall components of silages ($P<0.01$).

Table 4
The cell wall components of alfalfa and silages, g kg^{-1} DM

Treatments	NDF	ADF	ADL	hemicellulose	celulose
CON	428.6±0.12^{a}	299.3±0.03^{a}	72.8±0.04^{a}	129.3±0.15^{c}	226.5±0.07^{a}
WC2	405.0±0.11^{b}	260.9±0.05^{d}	56.4±0.05^{d}	144.1±0.09^{a}	204.5±0.01^{c}
WC3	383.1±0.13^{d}	245.4±0.04^{e}	60.9±0.74^{c}	137.7±0.1^{b}	184.5±0.04^{d}
WC4	400.1±0.16^{c}	263.1±0.03^{c}	57.6±0.06^{d}	137.0±0.19^{b}	205.5±0.03^{c}
WC5	400.3±0.18^{c}	279.0±0.05^{b}	65.8±0.03^{b}	121.4±0.19^{d}	213.1±0.06^{b}
P-value	<0.001	<0.001	<0.001	<0.001	<0.001

CON- Control, WC2-Whipped cream 20 g kg^{-1}, WC3-Whipped cream 30 g kg^{-1}, WC4-Whipped cream 40 g kg^{-1}, WC5-Whipped cream 50 g kg^{-1}, NDF-Neutral detergent fiber, ADF-Acid detergent fiber, ADL-Acid detergent lignin, ± SEM-Standart error of means, $^{a-d}$-Means with different letters in the same column are statistically significant ($P<0.01$).

The lowest (Figure 5) was determined in the NDF and ADF WC3 group. It is possible that the decrease of contents in NDF and ADF is due to the effect of pH.

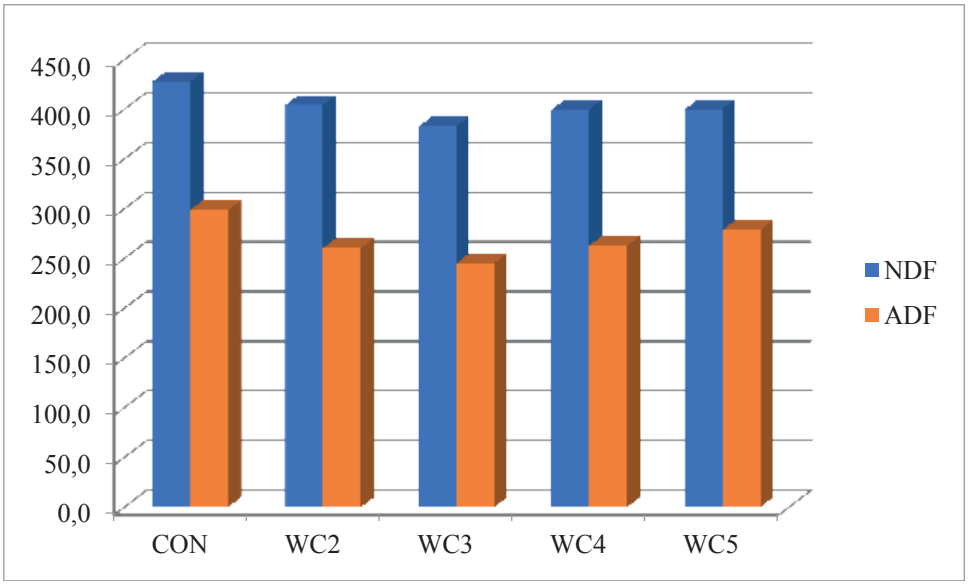

Figure 5. Change in NDF and ADF of alfalfa silages g kg^{-1}, CON- Control, WC2-Whipped cream 20 g kg^{-1}, WC3-Whipped cream 30 g kg^{-1}, WC4-Whipped cream 40 g kg^{-1}, WC5-Whipped cream 50 g kg^{-1}.

Microbiological analysis results of silages are given in Table 5. It was found that LAB (Figure 6) increased significantly (P<0.01), yeast counts decreased in WC3, and enterobacter and mold did not develop with the addition of whipped cream (P<0.01).

Table 5
Microbiological analysis results of alfalfa silages, log10 cfu/g

Treatments	LAB	TMAB	Yeast	Mold	Enterobacter
CON	4.69±0.16^{d}	9.12±0.08^{b}	4.43±0.22^{ab}	ND	ND
WC2	6.03±0.02^{c}	10.18±0.10^{a}	3.22±0.08^{c}	ND	ND
WC3	7.05±0.05^{a}	10.39±0.20^{a}	3.73±0.11^{bc}	ND	ND
WC4	6.71±0.06^{ab}	10.41±0.09^{a}	4.49±0.18^{a}	ND	ND
WC5	6.99±0.06 ^{bc}	10.05±0.10^{a}	5.15±0.15^{a}	ND	ND
P-value	<0.01	<0.01	<0.01	-	-

CON- Control, WC2-Whipped cream 20 g kg^{-1}, WC3-Whipped cream 30 g kg^{-1}, WC4-Whipped cream 40 g kg^{-1}, WC5-Whipped cream 50 g kg^{-1}, TMAB-Total mesophilic aerobic bacteria, LAB-Lactic acid bacteria± SEM-Standart error of means, $^{a-d}$-Means with different letters in the same column are statistically significant (P<0.01).

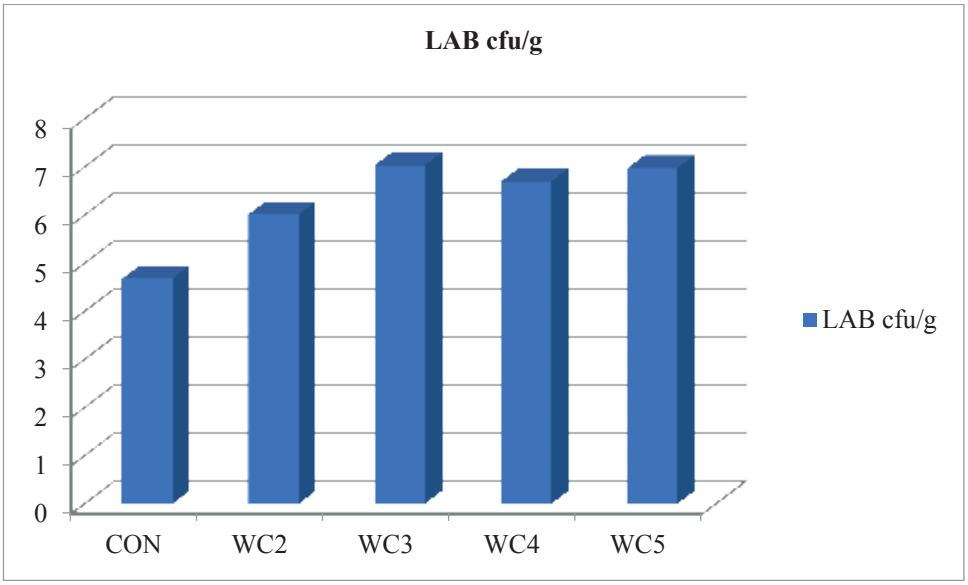

Figure 6. Change in LAB counts of alfalfa silages, CON- Control, WC2-Whipped cream 20 g kg^{-1}, WC3-Whipped cream 30 g kg^{-1}, WC4-Whipped cream 40 g kg^{-1}, WC5-Whipped cream 50 g kg^{-1}, LAB-Lactic acid bacteria.

Whipped cream added to alfalfa as a carbohydrate source increased LAB's activity (Figure 6) in the silage environment, causing the cell wall components to break down. Thus, a decrease occurred in the contents of NDF, ADF, and ADL (Table 4). It is reported that carbohydrate sources in silages, primarily LAB, increase the degradation of NDF, ADF (Figure 5), and hemicellulose in silage by activating the growth of some anaerobic bacteria (Yayla & Soycan Önenç, 2021). With this study and Malhatun-Çotuk and Soycan-Önenç (2017) were similar.

If the yeast counts exceed 5 log cfu/g (naturally) in the silages, it is considered as an indication that the silage has deteriorated (Wilkinson & Davies, 2013). In this study, yeast counts decreased in WC3 group similar to the study of Yayla and Soycan Önenç (2021). However, it is above the critical value reported by Wilkinson and Davies (2013) in WC5. Since air entry is not possible during fermentation, the yeast population may be yeasts in the starting material, but the pH below 4 (WC2 and WC3) suppressed yeast growth. In addition, it is reported that withering also stimulates yeast growth, yeasts in silage can also grow in anaerobic conditions and use WSC as a nutrition source (Turan & Soycan Önenç, 2018; Yayla & Soycan Önenç, 2021). In the study, the application of withering stimulated the growth of yeast in the begining material, and the addition of whipped cream provided an increase in WSC in the silage, and the number of yeasts using WSC as a nutrition source increased in silages.

It is more sensitive to acidity in silages than *Listeria and Enterobacteria, Clostridia* spores. Therefore, if the pH of the silage decreases rapidly and the acid environment is formed, the growth of *Listeria and Enterobacteria* can be more suppressed

at the beginning of the fermentation (Kurtoğlu, 2011). WC2 and WC3 levels lowered the pH in the silage environment, so there was no enterobacter and mold growth. The decrease in yeast numbers in groups in question is due to the low pH.

Digestible dry matter contents were found as 65.58% in the lowest control group (Table 6) and 69.78% in the highest WC3 group (P <0.01). In the study, the highest DDM was found in the WC3 group. This is due to the contents of the ADF. Due to the DDM levels are calculated using ADF contents, it increased inversely with the decrease in ADF. Since the digestion level of ADF is very slow, this value is desired to be low (Yayla & Soycan Önenç, 2021).

Table 6
Digestible dry matter, dry matter intake and relative feed value contents of alfalfa silages

Treatments	DDM,%	DMI,%	RFV
CON	65.58±0.02^{e}	2.80±0.01^{d}	142.34±0.33^{d}
WC2	68.58±0.04^{b}	2.96±0.01^{c}	157.52±0.52^{bc}
WC3	69.78±0.3^{a}	3.13±0.01^{a}	169.43±0.66^{a}
WC4	68.40±0.02^{c}	3.00±0.01^{b}	159.02±0.59^{b}
WC5	67.17±0.04^{d}	3.00±0.01^{b}	156.09±0.71^{c}
P-value	<0.001	<0.001	<0.001

CON- Control, WC2-Whipped cream 20 g kg^{-1}, WC3-Whipped cream 30 g kg^{-1}, WC4-Whipped cream 40 g kg^{-1}, WC5-Whipped cream 50 g kg^{-1}, DDM-Digestible dry matter, DMI-Dry matter intake, RFV-Relative feed value, ± SEM-Standart error of means, $^{a-d}$-Means with different letters in the same column are statistically significant (P<0.01).

Besides this, it was found that with the addition of whipped cream to alfalfa silage, DDM increased compared to the CON group but decreased depending on the level of increase. Whipped cream added to alfalfa silage at a high level negatively affected ADF and caused a decrease in DDM. It was reported that the increase in NDF, ADF and ADL levels, which are in the structure of feeds and slow down digestion, physically cause the animal to feel satiety and limit the feed intake of the animals (Malhatun-Çotuk & Soycan-Önenç, 2017).

Dry matter consumption was 2.80%, 2.96%, 3.13%, 3.00% and 3.00% in control, WC2, WC3, WC4 and WC5 groups, respectively. RFV (Figure 7) calculated using DDM and DMI values was the lowest in the control group (142.34) and the highest in the WC3 (169.43) group.

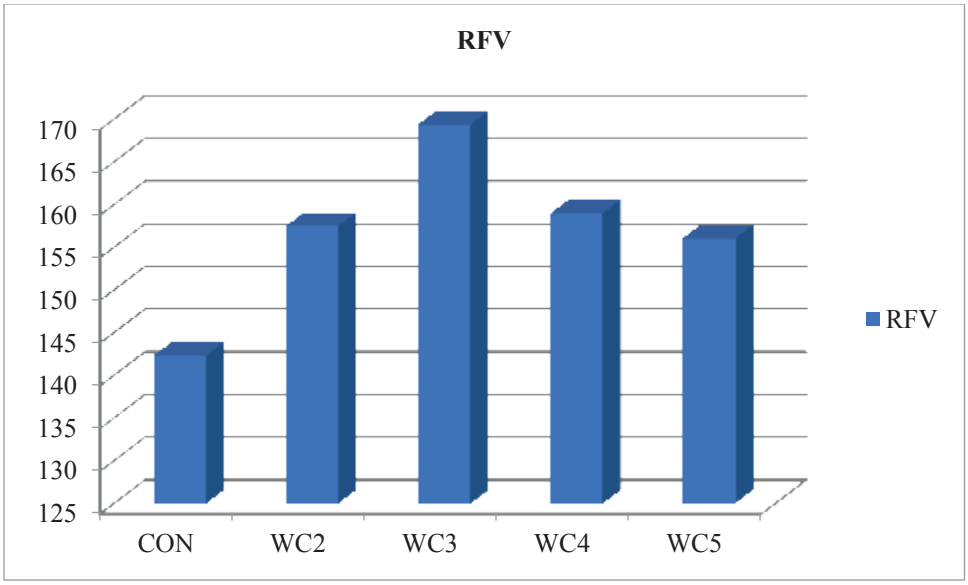

Figure 7. Change in RFV of alfalfa silages, CON- Control, WC2-Whipped cream 20 g kg^{-1}, WC3-Whipped cream 30 g kg^{-1}, WC4-Whipped cream 40 g kg^{-1}, WC5-Whipped cream 50 g kg^{-1}, RFV-Relative feed value.

The addition of whipped cream increased DMI and RFV compared to the CON. Whipped cream added to silage caused a decrease in the NDF content of alfalfa silage. The cell wall contents (ADF, NDF) of silage are important quality parameters, which affect the digestibility of alfalfa silage and animal performance (Aktürk, & Gümüş, 2020). Considering at DDM, DMI, RFV of the alfalfa from which the silages are made, it is seen that all silages except the control group have an advantage over dry grass. DDM, DMI, and RFV determined in the study were lower than the values of Malhatun-Çotuk and Soycan-Önenç (2017) working with alfalfa, but similar to Bostan's (2016) study. All groups to which whipped cream is added have RFV values above 150 (Redfearn, Zhang, & Caddel, 2012) are the best quality silages, and the starting material and control group is between 125 and 150, indicating that they are in the 1st quality class.

ME contents calculated using cell wall components are given in Table 7. While the lowest ME_{DDM}, ME_{NDF}, ME_{ADF} and ME_{ADL} contents were found in the control group, the highest was found in the WC3 group (ME_{DDM}:2357, ME_{NDF}: 2616, ME_{ADF}:2633 kcal kg^{-1} DM) excluding ME_{ADL} ($P < 0.01$). In the ME equation based on ADL, the highest ME_{ADL} contents (WC2: 2184.9, WC4: 2172.8 kcal kg^{-1} DM) of the WC2 and WC4 groups were determined ($P < 0.01$).

Table 6
Digestible dry matter, dry matter intake and relative feed value contents of alfalfa silages

Treatments	ME_{DDM}	ME_{NDF}	ME_{ADF}	ME_{ADL}
CON	2186.7±1.01^{e}	2525.6±2.30^{c}	2440.3±1.15^{e}	2016.2±4.09^{d}
WC2	2308.4±1.72^{b}	2572.7±2.29 ^{b}	2578.2±1.95^{b}	2184.9±5.45^{a}
WC3	2357.4±1.21^{a}	2616.4±2.65 ^{a}	2633.6±1.37^{a}	2138.8±7.59^{b}
WC4	2301.2±0.93^{b}	2582.4±3.19 ^{b}	2570.1±1.10 ^{c}	2172.8±6.1 ^{a}
WC5	2251.1±1.62^{d}	2582.1±3.63^{b}	2513.3±1.84^{d}	2088.4±3.20^{c}
P-value	<0.001	<0.001	<0.001	<0.001

CON- Control, WC2-Whipped cream 20 g kg^{-1}, WC3-Whipped cream 30 g kg^{-1}, WC4-Whipped cream 40 g kg^{-1}, WC5-Whipped cream 50 g kg^{-1}, ± SEM-Standart error of means, $^{a-d}$-Means with different letters in the same column are statistically significant (P<0.01).

Another study reported that adding pudding to alfalfa caused a decrease in NDF, ADF, ADL, and increased the ME_{NDF}, ME_{ADF}, and ME_{ADL} calculated from these values (Malhatun-Çotuk & Soycan-Önenç, 2017). Ensilaging alfalfa by adding whipped cream as a source of WSC has positively affected the energy content of silages.

Conclusion

The addition of whipped cream, food industry waste as an alternative carbohydrate source in the final forms of alfalfa positively affected the chemical and microbiological properties of silages. Primarily, the increased amount of water soluble carbohydrates provided a source for the growth of lactic acid bacteria. Accordingly, the number and efficiency of LAB have also increased. Hence, the conversion of sugars to lactic acid has increased, the lactic acid present in the environment at high rates has inhibited the enzymes that break down proteins by lowering the pH, and the breakdown of proteins into ammonia has also decreased. Besides, the amount of digestible dry matter, relative feed value, and dry matter consumption rate also increased.

Findings from this study revealed that in spring and autumn, quality alfalfa silage could be obtained by adding 20 or 30 g kg^{-1} of whipped cream to alfalfa, and it can be recycled by using waste whipped cream, a silage additive and can be recycled.

Conflict of Interest

We certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

Author Contributions

SSÖ: Designed the study, did collected data and whrote the article, DY: Did collected data supported in providing literature, MİŞ: Did collected data supported in providing literature.

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