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Research Article

Effect of use of potato chips waste as a source of easily soluble carbohydrates in alfalfa silage on silage quality

Besime Doğan Daş[1], Mehmet Avcı[1], Aydın Daş[2], Nurcan Kırar[1], Mücahit Kahraman[2], Mehmet Emin Aydemir[3]

[1]Department of Animal Nutrition and Nutrition Diseases, Faculty of Veterinary Medicine, Harran University, Sanliurfa/Türkiye
[2]Department of Animal Science, Faculty of Veterinary Medicine, Harran University, Sanliurfa/Türkiye
[3]Department of Food Hygiene and Technology, Faculty of Veterinary Medicine, Harran University, Sanliurfa/ Türkiye

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Correspondence:
B. DOĞAN DAŞ
(bdas@harran.edu.tr)

ORCID
B. DOĞAN DAŞ : 0000-0003-2163-2632
M. AVCI : 0000-0002-2523-2137
A. DAŞ : 0000-0003-0371- 5434
N. KIRAR : 0000-0002-2778-1789
M. KAHRMAAN : 0000-0002-7757-2483
ME. AYDEMİR : 0000-0002-5849-1741

ABSTRACT

The goal of this study was to examine the effect of adding potato chips waste, which is a by-product of the potato processing industry, on silage quality, as an easily soluble carbohydrate source, to the alfalfa (Medicago sativa L.) plant, which has a high buffering capacity and is therefore difficult to ensilage. In the study, alfalfa (Medicago sativa) harvested at the 10% flowering point was used as the plant material. Trial groups of silages prepared by adding potato chips waste to alfalfa at the rates of 0% (control), 0.5%, 1% and 2% by wet weight were formed. After the 60-day fermentation period was complete, the silages were opened, and the nutritional compositions and fermentation products were identified. When silages made with various amounts of chips were analyzed, variations between the groups in terms of dry matter (DM), crude ash (CA), acid detergent finer (ADF), and neutral detergent fiber (NDF) content of the silages that were generated by the research were statistically significant. The differences between the silage groups were discovered to be statistically significant, despite the fact that they were not significant in terms of CP content. In the study, reductions were seen as a result of the addition of chips in comparison to the control group when the pH, ammonia nitrogen (NH_3-N), carbon dioxide (CO_2) production, and total yeast mold values of the fermentation properties of the silages were studied. With the addition of 1% chips, an increase in the silages' total lactic acid bacteria (LAB) levels was seen. As a result, when all the parameters were examined, it was determined that the silages prepared by adding 1% chips waste had positive effects on silage fermentation.

INTRODUCTION

Alfalfa (*Medicago sativa*), which is called the queen of forage plants, is oftenly dried and fed to the animals. However, significant nutrient losses occur during drying and storage (McDowell 1989; Oktay et al., 1990). In recent years, besides its use as a dry grass, its silage has also gained importance (Çerçi et al., 1996). Due to the high level of alfalfa protein, it is classified as difficult ensiled feeds (Ergün et al., 1999). It is challenging to obtain quality silages from such feeds. For this reason, different additives are used to ensure the fermentation of silage fodder plants that are low in carbohydrates and rich in protein, but additives are mostly used to account for the carbohydrate deficit in the the subject plant (Güler, 2001; Şahin et al., 1999). The potato (*Solanum tuberosum L.)* plant is a member of the Solanacae family. Potato-producing countries include China, India, Russia, Ukraine and the USA. It was first cultivated in Turkey at the end of the nineteenth century. On the basis of regions in Turkey, it was first cultivated in the Eastern Black Sea region and then in the Western Thrace region (Berksan, 2002). Approximately half of the potatoes produced in the world are consumed fresh, while the other half is used as processed food product, animal feed, industrial starch and seed. Potatoes are mainly processed into frozen products and chips. The remaining amount is consumed in areas such as processed potatoes, animal feed, seed, industrial starch, which have areas of use such as chips and French fries.

Potato skins and the other parts of the potato that remain as waste after consumption contain a high percentage of starch (Özdemir & Malayoğlu, 2017). The potato plant is one of the basic foods consumed for nutrition by the world population and it contains plenty of carbohydrates, proteins, vitamins and minerals in its structure. Therefore, it is a plant with a high nutritional value (Onaran, 2002). As a result of industrial and agricultural applications, large amounts of potato by-products are produced every year. Although the potential properties of these by-products cannot be exploited, these by-products are often left to the environment by businesses who are faced with serious environmental problems (Hofvendahl &Hahn-Hagerdal, 2000). This study aimed to use potato chips waste, which is one of the by-products of the potato processing industry that causes environmental pollution, as an easily soluble carbohydrate source in alfalfa silage.

MATERIAL and METHODS

In the study, alfalfa (*Medicago sativa*) harvested at the 10% flowering point was used as the plant material. The potato chips waste was added to the alfalfa at the rates of 0.5%, 1% and 2% on a wet weight basis. After the alfafa was harvested, it was left to wither up to the DM content of 30 or 25% approx, and it was then chopped in 1.5-2.0 cm dimensions. In the study, four different silage groups were identified and four replications were formed in each group. After adding the potato chips waste to approximately 1 kg of crushed alfalfa samp-

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les, they were placed in 1.5 liter airtight glass jars, their mouths were tightly closed, and they were left for fermentation for 60 days by being ensiled at room temperature. At the conclusion of the 60-day fermentation period, the silages were opened, and the 3-5 cm portions at the jar tops were removed and discarded. After the silages were opened, 25 g of silage sample was crushed in a blender with 100 ml of distilled water and its pH was measured (Polan et al., 1998). Then the obtained filtrates were placed in centrifuge tubes. For ammonia nitrogen analysis, 0.1 ml of 1M HCl was added to the centrifuge tubes and stored at -18°C. Using the method described by Broderick & Kang (1980), ammonia nitrogen analysis of the silage samples were carried out.

Dry matter (DM), crude protein (CP) and crude ash (CA) analyzes were performed according to the Weende analysis system (AOAC, 1990), and ADF and NDF analyzes were performed according to the method reported by Van Soest et al. (1990). The silages were subjected to an aerobic stability test [determination of carbon dioxide (CO_2) production values] for five days (Ashbell et al., 1991). The silage materials and the obtained silages were dried by air drying method and ground in a laboratory mill to pass through a 1 mm sieve, and nutrient composition analyzes were made. The total lactic acid bacteria (LAB) count in the silage material was determined using the method reported by Güney & Ertürk (2020) according to the tempo automatic bacteria counter test method. The total

Table 1. Nutrient analysis of chips waste and siloed alfalfa

Nutrients	DM	CA	CP	ADF	NDF
Alfalfa	31.60	10.65	14.95	25.57	41.04
Chips Waste	88.90	2.88	7.50	3.50	9.86

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

Table 2. Nutrient content of silages prepared by adding chips waste at different rates to alfalfa plant

Groups	DM	CA	CP	ADF	NDF
Control	34.38	11.35	16.30^{a}	23.46	40.33
0.5% Chips Waste	34.32	11.44	16.20^{b}	21.18	41.00
1% Chips Waste	34.54	11.15	16.14^{bc}	21.47	40.59
2% Chips Waste	34.20	11.08	16.08^{c}	22.39	39.12
SEM	0.133	0.095	0.024	0.409	0.320
P	0.870	0.560	0.001	0.195	0.188

a-d:Values with different letters in the same column were found to be different ($P<0.05$), SEM:Standart Error of Mean; DM: Dry matter, %; CA: Crude ash, DM%, CP: Crude protein, DM%, ADF: Acid detergent fiber, DM%; NDF: neutral detergent fiber, DM%.

Table 3. Fermentation contents of silages prepared by adding chips waste at different rates to alfalfa plant

Groups	PH	NH_3-N	CO_2	Total Yeast-Mold cfu/g	LAB kob/g
Control	5.02^{a}	9.580^{a}	2.755^{a}	8.54^{a}	7.21^{b}
0.5% Chips Waste	4.78^{b}	4.797^{b}	2.012^{b}	6.92^{b}	7.55^{b}
1% Chips Waste	4.56^{c}	3.687^{b}	1.908^{b}	6.34^{c}	7.58^{a}
2% Chips Waste	4.32^{d}	3.750^{b}	1.500^{b}	6.25^{c}	5.89^{b}
SEM	0.069	0.652	0.153	0.240	0.228
P	0.000	0.000	0.012	0.000	0.008

a-d;Values with different letters in the same column were found to be different ($P<0.05$), SEM:Standart Error of Mean; CO_2: Carbon dioxide formation, g/kg DM, NH_3-N/TN: Ammonia nitrogen, LAB: Lactic Acid Bacteria cfu/g.

amount of yeast and mold contained in the silages were determined using the method reported by Filya et al. (2000).

The data obtained at the end of the research were evaluated with one-way analysis of variance (One-way Anova) using the SPSS statistical software program (SPSS, 2008). Duncan's multiple range test was used to compare the mean between groups. The significance level of differences between groups was made according to $p<0.05$.

RESULTS

The study's chemical composition of alfalfa and potato chips waste used as silage material is presented in Table 1.

The silage nutrient content of the addition of the potato chips waste at different rates (0.5%, 1%, and 2%) to the alfalfa silage is presented in Table 2 and the fermentation characteristics are presented in Table 3.

The differences between the groups were determined to be statistically insignificant ($p>0.05$) when the silages' DM, CA, ADF, and NDF values were investigated in Table 2, but they were statistically significant ($p<0.05$) when it came to CP va-lues.

When the pH, NH_3-N, CO_2, yeast mold and LAB values of the silages were examined in Table 3, the differences between the groups were found to be statistically significant ($p<0.05$). Although the control group's silages had the highest pH value, a drop in pH was seen as a result of the rise in chips waste.

DISCUSSION

In this study, a decrease in the CP values was observed in all the experimental groups due to the increase in chips waste. It was concluded that this downward trend was due to the low protein content of the chips waste added to the alfalfa silage. The reason why there was no significant difference in the ADF and NDF values between the control and experimental groups in this study was thought to be related to the fact that the chips waste could not increase the low LAB activity in the environment and therefore the cell wall components in the silages were not broken down.

Due to the low concentration of water-soluble carbohydrates in the alfalfa plant, the pH values in the additives groups were found to be lower than those in the control group. The pH values of the silages are affected by many factors such as the type of LAB used, the water soluble carbohydrate content of the plant, the dry matter level, and the buffering capacity (Basmacıoğlu & Ergül, 2002). Silo fermentation affects the nutritional value and hygienic structure of silages. The pH formed during fermentation is extremely important and is an important parameter used to determine silage fermentation and silage quality (Filya, 2000).

In the study, when the silage NH_3-N values were compared with the control group, a decrease was observed in the silages prepared with the addition of potato chips waste ($p<0.05$). It is thought that easily soluble carbohydrate sources have a positive effect on silage fermentation and reduce proteolysis (Bingöl, 2009). The total yeast mold values and CO_2 content of the silages with all additives applied were found to be lower than those of the control group ($p<0.05$). The main microorganisms responsible for aerobic deterioration are yeast and molds. Filya (2001) reported that the intense CO_2 production in silages is an indicator of aerobic deterioration of the silages. Filya (2002) also noted that the presence of unused sugars after fermentation reduces the aerobic stability of silages during the period when the silages are opened for use in feeding and are exposed to a completely unlimited air intake. Similarly, Canpolat et al. (2010), reported that the addition of grape pomace as an easily soluble carbohydrate source to alfalfa silage improved the aerobic stability value. When the silages' total LAB values were looked at, an increase was observed with the addition of 1% chips waste, the fact that the highest LAB value (7.58) and the lowest yeast mold value (6.34) were in the silage group with a 1% chips waste addition, the amount of acetic acid produced by the LAB fermentation inhibited the growth of yeast and molds (Driehuis & Elferink, 2000). Canpolat et al. (2013) reported that the addition of gladia fruit as an easily soluble carbohydrate source to alfalfa silage increased the LAB value and reduced the mold, which supports the findings of this study.

CONCLUSION

When all the parameters of the study were examined, it was observed that the silages prepared by adding 1% chips waste had positive effects on silage fermentation. Additionally, it was determined that chips waste can be added to the as an alternative, which can be used to increase the quality of the alfalfa silage, which is difficult to ensilage, and to increase the level of easily soluble carbohydrates in the silage.

DECLARATIONS

Ethics Approval

Not applicable.

Conflict of Interest

The authors declare that they have no competitive interests.

Consent for Publication

Not applicable.

Author contribution

Idea, concept and design: BDD

Data collection and analysis: AD, NK, MK, MEA

Drafting of the manuscript: BDD

Critical review: MA

Data Availability

Not applicable

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