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Can Thistles (*Carduus nutans* L.) be Considered as Silage with Some Additives?

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ABSTRACT: The aim of this study was to assess nutritional characteristics of thistle silages with additives. Thistle plant material collected around the faculty of Agriculture, Ataturk University in 2010 were ensiled without and with 1% salt, 5% barley meal, 1% molasses and 10% wheat straw in triplicates. Dry matter, crude protein contents and pH values varied from 51.77 to 60.16%, 8.54 to 11.84%, and 4.69 to 4.92, respectively. The fleigh score was determined as very good, although the physical grades of silages were medium. Acid detergent fiber and neutral detergent fiber contents and relative roughage value varied from 39.00 to 47.8%, 57.23 to 65.32% and 73.57 to 94.31, respectively. The obtained silages was found rich in term of macro and micro minerals. The effects of additives on nutrient content and physical characteristics were variable. In conclusion, thistle silage can be used in feeding dry cows and young ruminants due to its protein, fiber, and mineral contents. Further harvesting stage and digestibility studies are needed to determine proper additive to improve nutritional characteristics.

Keywords: molasses, silage, fleigh score

Bazı Katkı Maddelerinin İlavesi ile Deve Dikeni Bitkisi (*Carduus nutans* L.) Silaj Olarak Değerlendirilebilir mi?

ÖZET: Bu çalışmanın amacı katkı maddeleri ile birlikte deve dikeni bitkisinin beslenme özelliklerinin belirlenmesidir. Bitki materyali 2010 yılında Atatürk Üniversitesi Ziraat Fakültesi arazisinden toplanmış, 3 tekerrürlü olarak kontrol, %1 tuz, %5 arpa kırması, %1 melas ve %10 buğday samanı kullanılmıştır. Kuru madde, ham protein içerikleri ve pH değerleri sırasıyla % 51.77-60.16, % 8.54-11.84 ve 4.69-4.92 arasında değişmiştir. Silajların fiziksel dereceleri orta düzeyde olmasına rağmen Fleigh puanı çok iyi olarak tespit edilmiştir. Asit çözücülerde çözünmeyen lif, Nötr çözücülerde çözünmeyen lif ve nispi yem değerleri sırasıyla % 39.00-47.82, %57.23-65.32 ve %73.57-94.31 arasında değişmiştir. Elde edilen silaj makro ve mikro elementler bakımından zengindi Besin içerikleri ve fiziksel özellikler üzerine katkı maddelerinin etkileri değişkenlik göstermiştir. Deve dikeni silajı besin, lif ve protein içeriklerinden dolayı sığırların ve genç geviş getiren hayvanlar için besin maddesi olarak kullanılabileceği tespit edilmiştir. Bununla birlikte hasat zamanı, besleme değeri ve katkı maddeleri üzerine ileri çalışmalara ihtiyaç vardır.

Anahtar kelimeler: melas, silaj, fleigh puanı

INTRODUCTION

Roughages constitute the greatest portion of production inputs in livestock production activities. Low-cost and nutritious forage sources are always attracted the attentions of the producers to minimize the costs and increase profitability. Giant fennel Ertus et al. (2009) and various fruit pulps Yalcinkaya et al. (2012) appear to gain attention as alternative roughage sources in Turkey, especially when forage shortage alarms.

Thistles (*Carduus nutans* L.) belonging to Asteraceae family have a significant potential as a possible forage source due to its nutritive value. Thistles belong to the Asteraceae family. It is an annual or biennial plant and naturally grows by roadsides, abandoned agricultural lands, and rough terrains. Plant height may reach 1 meter, yielding considerable mass production. Because it is a thorny plant, only donkeys, camels, and goats partially graze it when the plant is edible fresh. It is sometimes harvested and chaffed by villagers in some parts of the country and supplied as fodder resource for livestock feeding during the winter months in the Eastern Anatolia Region (Tan and Temel 2012).

Forages are stored in various ways. The quality may be increased through ensiling low-quality forage. Sometimes, supplementary additives are used to improve silage quality and preserve the quality for a long time even after opening the silage. With these additives, both lactic acid bacteria rapidly grow in ensiled material and good quality-well fermented silage with high aerobic stability and low hygienic risk can be achieved (Bolat et al. 1997). Commonly cereal grains, molasses, sugar and additives are used to compensate the carbohydrate deficit of the silage (Kilic, 1986).

Additives contribute to the chemical composition of the silage. For instance, Turemis et al. (1997) investigated the effects of different additives (molasses, grain meals and urea) on the quality of alfalfa, alfalfa + corn, alfalfa + sorghum and corn silages and reported increased dry matter content and decreased crude protein (CP) percentage in corn silage. While urea supplementation increased CP percentage and pH in alfalfa + corn, alfalfa + sorghum, and corn silages, grain meals and molasses decreased CP percentage of the silages without altering pH. It was shown that additions of 1% salt and 5% barley meal (BM) improved silage quality and nutritive value (Dumlu, 2007). This experiment was conducted to investigate effects of various supplements on quality of thistle (*Carduus nutans* L.) silage cut at growing stage.

MATERIALS and METHOD

Thistles (*Carduus nutans* L.) were harvested during the flowering period from the surrounding sites of Atatürk University, Agricultural Faculty, Erzurum, in the year 2010 and chaffed with a laboratory-type silage machine. The chaffed material was both ensiled directly and in single, double and triple combinations of 1% salt (S), 5% barley meal BM, 1% molasses (M) or 10% wheat straw (WS). There were a total of 15 treatments, replicating each thrice.

Dry matter (DM) content was determined at 60^{o}C oven by storing 24 hours. The CP content was determined using the Kjeldahl method (Bremner, 1996). The ADF and NDF contents as well as pH value were determined in accordance with the methods described by Kilic (1986). The mineral contents (P, K, Ca, Mg, Na, S, Cu, Fe, Zn) were attained using Inductively Couple Plasma Spectrophometer (Perkin-Elmer, Optima 2100 DV, ICP/OES, Shelton, CT, USA) (Mertens, 2005). Silages were evaluated physically when they were opened. In physical evaluations, odor (with a scale of 0, 2, 4, 8 and 14 points), structure (with a scale of 0, 1, 2 and 4 points) and color (with a scale 0, 1 and 2 points) were scored to be "very good", "good", "medium", "low", and "very low" if total score was 18-20, 14-17, 10-13, 5-9, and 0-4, respectively (Kilic, 1986).

The data were subjected to variance analysis with the General Linear Model using SPSS statistical software (SPSS, 1999). Group means were compared with Duncan's Multiple Range test. Statistical significance was declared at P<0.05.

RESULTS

Adding WS increased DM level. The DM contents of unsuplemented thistle and supplemented with S, BM, M, and WS varied from 51.77 to 60.16% (Table 1) and there was significant differences among treatments (p<0.01). The addition of BM and M, further increased the CP content of silages and there was a strongly relation with sole and mixture supplement (Table 1) (p<0.01). CP varied between 9.00–11.84%. A significant quality indicator for silages is pH. Optimum silage pH should range from 3.7 to 4.2. The additives did not alter thistle silage pH (4.69–4.92, Table 1). The fleigh score of all silage samples was 100 and silage quality was very good.

This suggests that there is no need for additives to increase the thistle silage fleigh score (Table 1). The physical grade of thistle silages with additive S, WS, BM and M was low but physical grade were medium at the mixture of S + M and S +WS + BM (Table 1). The additives significantly altered the ADF content of thistle silages (39.00-47.83%, p<0.01; Table 1). Adding WS increased the ADF content, whereas adding M decreased the ADF content. The NDF content was mostly similar to ADF content and it ranged from 57.20 to 65.32% (Table 1).

Table 1. Dry matter ratio, crude protein content, pH, fleigh score and physical grade ADF, NDF and RFV of thistle silages[1]

Treatment[2]	Dry Matter (%)	CP (%)	pH	Fleigh Score	Physical Grade	ADF (%)	NDF (%)	RFV (%)
C	51.77 F	9.36CD	4.69	100 very good	6.00 low	42.70 B	60.13 BC	86.40 B
S	56.57 A-E	9.31 CD	4.92	100 very good	7.00 low	42.75 B	60.05 BC	86.43 B
WS	56 A-F	9.33 CD	4.86	100 very good	8.00 low	47.80 A	65.28 A	73.64 C
BM	53.11 EFG	10.55 BC	4.57	100 very good	7.00 low	41.80 BC	58.90 C	89.07 AB
M	52.23 FG	10.76 AB	4.53	100 very good	7.00 low	39 D	57.80 C	94.31 A
S+WS	57 A-E	9.00 D	4.88	100 very good	6.00 low	47.82 A	65.32 A	73.57 C
S+BM	53.78 D-G	9.84 BCD	4.83	100 very good	8.00 low	41.83 BC	58.95 C	88.96 AB
S+M	57.28 A-D	10.39 BC	4.78	100 very good	11.00 medium	40.0 CD	58.15 C	92.51 AB
WS+BM	58.16 ABC	9.43BCD	4.80	100 very good	7.00 low	46.52 A	64.82 A	75.60 C
WS+M	57.61 A-D	10.48 BC	4.72	100 very good	7.00 low	47.22 A	64.90 A	74.74 C
BM+M	54.06 C-G	10.09 ABC	4.48	100 very good	6.00 low	39.80 CD	57.20 C	94.21 A
S+WS+BM	59.82 A	9.65 BCD	4.74	100 very good	12.00 medium	47 A	65 A	74.87 C
S +WS+M	58.49 AB	10.0 BCD	4.77	100 very good	5.00 low	47.22 A	64.91 A	74.76 C
S+BM+M	54.60 B-G	9.60 BCD	4.69	100 very good	7.00 low	39.85 CD	57.23 C	94.08 A
WS+BM+M	60.16 A	11.84 A	4.76	100 very good	9.00 low	45.90 A	63.56 AB	77.87 C

Physical Grade: 0-4: very low, 5-9: low, 10-13: medium, 14-17: good, 18-20 very good

[1]Means with small or capital letters in the same column were different P<0.05 and P<0.01, respectively.

[2]C = no additive; S = salt (1%); WS = wheat straw (10%); BM = barley meal (5%); M = molasses (1%).

Mineral content of thistle silages with additives altered depending on additives and mineral types. The phosphorus content of thistle silages varied between 0.25 and 0.42% (Table 2) and there were significant differences among applications ($p<0.01$). Adding BM and M elevated P content of thistle silage (0.3%). The highest K content obtained from C + M (1.87%) application but BM, S +WS, WS + M, S + BM + M and WS + BM + M applications were statistically same group (Table 2) ($p<0.05$). It decreased by adding S and WS and increased by adding BM and M. No changes in Ca content were measured by additives and Ca content ranged from 1.09 to 1.68% (Table 2). Mg content of thistle silages was 0.14–0.31% (Table 2). Mg content of thistle silage (0.16%) increased by BM and M additions and decreased by WS addition. There were significantly differences among additives ($p<0.01$). Sodium, S, Cu, Fe and Zn are within the recommended level without causing toxicity, contents of thistle silage samples varied by the type of additives and also there were significantly differences among the type of additives (Table 2) ($p<0.01$).

Table 2. P, K, Ca, Mg, Na, S, Cu, Fe and Zn contents of pure and supplemented thistle silages[1]

Treatment[2]	P (%)	K (%)	Ca (%)	Mg (%)	Na (%)	S (%)	Cu (mg/kg)	Fe (mg/kg)	Zn (mg/kg)
C	0.30 CDE	1.25 cd	1.10	0.16 FG	0.24 BC	0.07 CDE	15.61 FGH	251.43 C	14.75 DEF
C+S	0.27 DE	1.17 d	1.27	0.20 DEF	0.24 BC	0.09 A-D	13.77 GH	358.10 A	21.54 ABC
C+WS	0.29 DE	1.33 bcd	1.54	0.14 G	0.20 D	0.09 AB	12.67 H	349.13 A	13.11 EF
C+BM	0.33 CD	1.56 a-d	1.30	0.24 B-E	0.23 C	0.08 BCD	20.41 DEF	262.96 C	17.16 B-F
C+M	0.33 CD	1.87 a	1.51	0.26 ABC	0.22 CD	0.07 DE	16.35 FGH	314.65 ABC	16.47 C-F
C+S+WS	0.27 DE	1.60 abc	1.28	0.18 EFG	0.23 C	0.07 CDE	17.36 E-H	361.95 A	23.06 A
C+S+BM	0.31 CDE	1.38 bcd	1.23	0.31 A	0.21 CD	0.07 DE	30.38 A	251.62 C	21.72 ABC
C+S+M	0.42 A	1.46 bcd	1.09	0.30 AB	0.29 A	0.06 E	18.84 D-G	379.98 A	18.76 A-D
C+WS+BM	0.32 CDE	1.34 bcd	1.33	0.29AB	0.23 CD	0.07 B-E	23.91 BCD	279.10 BC	15.90 DEF
C+WS+M	0.31 CDE	1.52 a-d	1.45	0.25 BCD	0.18 EF	0.10 A	14.28 GH	372.27 A	18.15 A-E
C+BM+M	0.37 ABC	1.38 bcd	1.29	0.29 AB	0.26 AB	0.06 E	28.51 ABC	267.37 C	19.03 A-D
C+S+WS+BM	0.34 BCD	1.48 bcd	1.68	0.27AB	0.17 F	0.07 DE	23.29 CD	346.98 AB	17.23 B-F
C+S +WS+M	0.34 BCD	1.37 bcd	1.48	0.28 AB	0.23 CD	0.06 E	22.39 DE	278.14 BC	22.39 AB
C+S+BM+M	0.41 AB	1.56 a-d	1.36	0.30 AB	0.28 A	0.07 DE	28.92 AB	311.49 ABC	19.73 A-D
C+WS+BM+M	0.25 E	1.70 ab	1.17	0.21 C-F	0.21 CD	0.09 ABC	12.40 H	338.76 AB	12.29 F

[1]Means with small or capital letters in the same column were different $P<0.05$ and $P<0.01$, respectively.

[2]C = no additive; S = salt (1%); WS = wheat straw (10%); BM = barley meal (5%); M = molasses (1%).

DISCUSSION

Silages are usually made to supply succulent feed to livestock. Therefore, higher DM content is not desired in silages. Corn is the best silage crop worldwide and its DM generally does not exceed 30% (Tumer, 2001). However, in the present study, the lowest DM level was greater than 50%, suggesting that this plant does not necessitate supplement (*i.e.*, WS) to increase DM further. For thistle silage, early harvest and adding additives with water content appear to be suitable to decrease DM (Turemis et al. 1997). The additive of wheat straw has more dry matter than the other additives, increases dry matter content. The addition of BM and M further increased the CP content of silages in agreement with literature (Turemis et al. 1997; Dumlu, 2007; Avci 2005 et al. 2005). However, WS and S additions decreased CP percentage. These could be due to greater CP content of BM and M and lower CP content of WS and S than thistle (Gungor et al. 2008). A significant quality indicator for silages is pH that it should range from 3.7 to 4.2. A pH value over 4.2 is not desired in silages (Kilic, 2010). It is known that BM and M lead to the formation of a proper medium for lactic acid bacteria, which decreases silage pH (Hunt et al. 1993). The data suggest that higher rates of BM, M, or in combination should be used in thistle silage. All silages had the high fleigh score (100%). The additive of some material did not affect the silage fleigh score. These suggest that S is beneficial to physically grade silage when carbohydrate sources are available. This may be due to the mineral content of the plant since cations (*i.e.*, Ca, Mg, and K) (Table 2) may increase buffer capacity and consequently decreased the fermentation of the silage (Collins and Owens, 2003). Additives rich in fermentable carbohydrate, such as BM and M decreased primary cell wall content of silage. This is related to enhance bacterial activity to degrade celullose and hemicelluloses (Bolsen et al. 1996). Moreover, there would be less contribution of fibers by BM (Dumlu, 2007; Avci et al. 2005). ADF and NDF content in wheat straw were found higher compared to the other additives. These increments in ADF and NDF of silages with adding wheat straw are due to the high cellulose and hemicellulose content of wheat straw. Increased in RFV by adding carbohydrate rich additives result from decreased ADF and NDF contents (Dumlu, 2007). The adding of wheat straw decreased RFV because of low energy, low digestibility, low protein content and low water soluble carbohydrate and high cellulose and hemicelluloses (Gungor et al. 2008).

Additives affected the concentrations of most minerals in the thistle silages. Adding BM and M elevated P content of thistle silage (0.3%) to the level that satisfies P requirement of the ruminant during the lactation period (0.35-0.4%) (NRC, 2001). The thistle silage with and without additives, except for S, M and BM, cannot meet demand for P by the dry cows (NRC, 2001). However, thistle silage K content can meet need for K (0.55–1.1%) (NRC, 2001). They are within the recommended level without causing toxicity (NRC, 2001). Generally, adding material increased K content of thistle silages. Calcium content ranged from 1.09 to 1.68%, which is within recommended levels (0.8–1.51%) for ruminants (NRC, 2001). The thistle silage appears to be poor source for meeting demand for Mg (0.25-0.35%) by the ruminants (NRC, 2001). The adding materials increased Mg content of thistle silages compared to control. Especially, adding S, M and BM increased and reached to recommended level for ruminant. Na content of thistle silage was 0.24%, which decreased by WS addition and increased by S addition. With and without additives, thistle silage could not supply sufficient Na for ruminants (0.5–0.6%) (NRC, 2001). All diets will need supplemental salt but salt is inexpensive hence salt deficiencies are extremely rare. Sulfur is an essential nutrient for rumen bacteria because of decreased fiber digestibility, microbial protein synthesis and feed intake. Sulfur content is inadequate with and without additives in the thistle silages for dairy cows (NRC, 2001). The requirement of Cu is 14 mg/kg for dairy cows. Adding S and WS decreased Cu level in the thistle silages. Iron requirement is 20-25 mg/kg. In the both with and without additives thistle silages have very high Fe concentrations. Zinc is under the recommended level without causing toxicity (NRC, 2001).

In conclusion, thistle silages were considerable CP and mineral sources in feeding dry cows and growing ruminants. Additives however failed to improve DM content, pH, and physical grade. Early harvest may overcome these limitations. Further in situ and in vivo studies are needed to evaluate digestibility and fermentation characteristics as well as animal performance.

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