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Effect of feeding pistachio by-products silage supplemented with polyethylene glycol and urea on Holstein dairy cows performance in early lactation

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ABSTRACT

This study was conducted to evaluate the effect of feeding pistachio by-products silage with or without supplementation of polyethylene glycol (PEG) and urea on intake, apparent total digestibility, ruminal fermentation and performance of dairy cows. Eight multiparous Holstein dairy cows averaging 61 ± 23 DIM and 38 ± 3.6 kg of milk production were used in a 4×4 replicated Latin square design. Fresh pistachio by-products (PB) averaging 32% dry matter (DM) were supplemented with PEG and urea at 1.0% and 0.5% of DM, respectively, and then ensiled for 60 day. Experimental treatments were as follows: (1) corn silage (15% of diet DM) as a control, substitution of corn silage with: (2) pistachio-by products silage (PBS), (3) PBS supplemented with urea, and (4) PBS supplemented with PEG. Intake of DM and apparent digestibility were not affected by treatments ($P > 0.05$). There was no difference in milk yield and composition ($P > 0.05$). However, a trend ($P < 0.07$) for more milk protein production (kg/d) and more ($P < 0.09$) milk fat concentration (%) was observed in cows fed PBS compared to those fed corn silage. The ruminal pH was similar among treatments ($P > 0.05$). There was significant difference in ruminal NH_3–N and serum urea N among treatments ($P < 0.05$). Results of this study show that under our experimental conditions, PBS can be substituted with corn silage up to 15% of diet DM in dairy cows ration without negative effects on animal performance.

1. Introduction

Pistacia vera L. is a tree widespread in Iran mainly in arid and semi arid zones. The large biomass of pistachio by-products (PB) (400,000 tones/year) is produced after de-hulling pistachio in Iran annually in late summer (Bagheripour et al., 2008). Due to high moisture and nutrients content of fresh PB, they mildew immediately and can be environmental polluter. The cheapest and easiest way to preserve and use these by-products for ruminant is ensiling. Using PB as an animal feed not only decrease forage shortage in hard conditions, but also reduce the risk of polluting environment. However, the use of these by-products by ruminants might be restricted due to high tannin content (Labavitch et al., 1982).

Tannins are a complex group of polyphenolic compounds widely distributed in plant species. Their effect may be either beneficial or detrimental to ruminants depending on the type of tannin, its chemical structure, molecular weight, the amount ingested and the animal species (Frutos et al., 2004). The inverse relationship between high tannin level in the forage and palatability, feed intake and digestibility in ruminants has been well established (Ben Salem et al., 2000; Silanikove et al., 1996). The anti nutritive effects of tannins in high level are due to their ability to bind with protein, carbohydrates

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and minerals and consequently decrease their digestion Mcsweeny et al. (2001).

Polyethylene glycol (PEG) and urea are substances which can limit tannin bioavailability and thereby increase the availability of macronutrients (Provenza et al., 2000). PEG is a polymer that binds to tannins irreversibly and prevents the formation of tannin–protein complexes (Makkar et al., 1995) or may break the already formed tannin–protein complexes (Makkar, 2003) thus increasing nutrients digestibility. Therefore, supplemental PEG to ruminants diet can reduce negative effects of tannins in ruminants (Provenza et al., 2000).

The purpose of this study was to determine whether pistachio by-products silage can be substituted corn silage and supplemental PEG and urea affected feed intake, digestibilities and milk production by dairy cows fed a diet containing tannin.

2. Materials and methods

2.1. Preparation of pistachio by-products silage

Ten thousand Kilograms of fresh pistachio by-products containing hulls (53.5%), twigs (27.7%), leaves (9.5%), hard shells (5.3%), and green kernels (4%) were collected from pistachio de-hulling factories in Feizabad (Khorasan Razavi Province, Iran) which is located on the north east part of Iran at 35°01′N latitude and 58°78′E longitude. The fresh pistachio by-products were ensiled in three separate silos with the capacity of 3000 kg. Treatments were as follows (Table 1): first, PB without additive; second, PB supplemented with solid urea at 0.5% of PB dry matter (average DM 32%) and third, PB supplemented with solid PEG (MW 4000) at 1.0% DM. Each treated PB was mixed perfectly and then was ensiled for 60 day.

Table 1
Chemical composition and phenolic compounds of silages.

Item	Treatment				
	CS	PBS	PBSU	PBSP	SEM
pH	4.21[b]	4.25[b]	4.34[a]	4.25[b]	0.024
Chemical composition, % of DM					
DM	23.5[b]	33.1[a]	33.6[a]	33.7[a]	0.23
CP	7.1[c]	12.0[b]	12.9[a]	12.0[b]	0.11
NDF	56.1[a]	36.6[b]	36.0[b]	36.5[b]	0.14
ADF	35.6[a]	26.1[b]	25.7[b]	26.0[b]	0.22
Acid detergent lignin	4.3[b]	9.7[a]	9.7[a]	9.7[a]	0.12
Ash	5.1[b]	11.9[a]	11.9[a]	12.0[a]	0.07
Total phenolics	nd	10.0[a]	9.4[b]	8.9[b]	0.17
Total tannins	nd	5.2[a]	4.4[b]	3.5[c]	0.13
Condensed tannins	nd	1.15	0.95	0.82	0.085
CP fractions, % of CP					
A	48.1[c]	50.2[b,c]	54.8[a]	52.0[b]	0.57
B1	4.0	3.8	4.5	5.2	0.38
B2	27.5[a]	25.8[a]	17.0[b]	18.7[b]	0.60
B3	11.1[b]	11.8[b]	15.5[a]	15.3[a]	0.20
C	9.3[a]	8.4[b]	8.2[b]	8.8[a,b]	0.15

CS=corn silage, PBS=pistachio by-products silage, PBSU=urea treated pistachio by-products silage, PBSP=polyethylene glycol treated pistachio by-products silage, DM=dry matter, OM=organic matter, CP=crude protein, NDF=neutral detergent fiber, ADF=acid detergent fiber, nd=not determined, SEM=standard error of the means.

[a,b,c] Means in a row without common superscript differ at $P<0.05$.

2.2. Animals, diets and experimental design

Eight multiparous Holstein dairy cows (643 ± 40 kg BW, 61 ± 23 DIM and 38 ± 3.6 kg of milk yield) were used in a 4 × 4 replicated Latin square design. Each experimental period lasted 21 day (14 for adaptation, 7 for measurements). Animals were kept in individual tie stalls in a barn, protected from rain and wind and equipped with individual troughs to facilitated quantitative measurement of feed intake. Cows were cared for in accordance with guidelines of the Iranian Council of Animal Care (NRC) (1995); four experimental diets were: (1) 15% of diet DM was corn silage (CS) as a control; substitution of corn silage with: (2) pistachio-by products silage with no additive (PBS); (3) PBS supplemented with urea at 0.5% of DM (PBSU); (4) PBS supplemented with PEG at 1.0% of DM (PBSP). Experimental diets were formulated to meet the requirements according to National Research Council (2001) for Holstein cows of 643 kg of BW and producing 45 kg of milk with 3.5% fat per day. Pistachio by-products silages gradually substituted with corn silage in the ration in order to minimize the probable risk of gastro-intestinal disorders due to tannin. Diets were fed as a Total Mixed Ration (TMR) with 38:62 forage to concentrate ratio and were formulated to have similar CP, NDF and NFC

Table 2
Feed ingredients and chemical composition of experimental diets.

Item	Treatment			
	CS	PBS	PBSU	PBSB
Ingredients (%)				
Alfalfa hay	23.0	23.0	23.0	23.0
Corn silage	15.0	0.0	0.0	0.0
Pistachio by-products silage	0.0	15.0	15.0	15.0
Whole cotton seed with lint	7.0	7.0	7.0	7.0
Corn	28.0	28.0	28.0	28.0
Soybean meal	7.0	7.0	7.0	7.0
Cotton seed meal	12.0	9.5	8.5	9.5
Wheat bran	4.5	7.0	8.0	7.0
Fat	1.5	1.5	1.5	1.5
Limestone	0.7	0.7	0.7	0.7
Vitamin–mineral mix[a]	1.0	1.0	1.0	1.0
Salt	0.3	0.3	0.3	0.3
Chemical composition, % of DM				
DM	63.8	70.6	70.6	70.6
OM	93.1	92.9	93.1	92.6
CP	16.4	16.6	16.6	16.6
ADF	22.3	20.2	20.9	20.2
NDF	32.6	30.8	31.4	31.0
NFC[b]	39.2	40.2	39.8	39.7
Ether extract	4.8	5.3	5.3	5.3
Tannins	–	0.77	0.65	0.51
Condensed tannins	–	0.18	0.15	0.12

CS=corn silage diet, PBS=pistachio by-products silage diet, PBSU=urea treated pistachio by-products silage diet, PBSP=polyethylene glycol treated pistachio by-products silage diet.

[a] Contained (/kg of premix; DM basis): 330,000 IU of vitamin A, 60,000 IU of vitamin D, 1000 IU of vitamin E, 160 g Ca, 85 g P, 63 g Na, 45 g Mg, 2100 mg Zn, 1500 mg Mn, 535 mg Cu, 12 mg Se, 45 mg I.

[b] NFC calculated as 100−(CP+Ash+NDF+EE).