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The Effect of Different Levels of Tannic Acid on some Performance Traits in Holstein Dairy Calves

Research Article

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ABSTRACT

The aim of this study was to evaluate the effect of inclusion of tannic acid on some performance traits and nutrient digestibility in Holstein dairy calves. A total of 20 seven days old Holstein calves were randomly assigned to 4 experimental treatments with 5 calves each. The treatments were as follows: 1) basal diet formulated to meet all nutritional requirement of calves according to NRC (2001) and milk without any additive, 2) basal diet and milk supplemented with 4 mg tannic acid/L, 3) basal diet and milk supplemented with 6 mg tannic acid/L and 4) basal diet and milk supplemented with 12 mg tannic acid/L. The result showed that dietary inclusion of different levels of tannic acid improved feed intake, body weight gain and feed conversion ratio in treated calves. Dry and organic matter intake, and digestion of crude protein, natural detergent fiber and acid detergent fiber were improved in treated calves with tannic acid compared to the control group. The fecal consistency score showed that Inclusion of tannic acid resulted in improved fecal consistency from0 to 50 days of age ($P \leq 0.05$). In conclusion, tannic acid inclusion in milk could be beneficial for Holstein dairy calves with positive effects on their feed intake, body weight gain, feed conversion ratio and nutrient digestibility.

KEY WORDS digestibility, fecal consistency, Holstein dairy calves, performance, tannic acid.

INTRODUCTION

Tannins are defined as naturally occurring water soluble poly-phenol of varying molecular weight, which differs from most other natural phenolic compounds in their ability to precipitate protein from solutions (Spencer *et al*. 1988). Tannic acid is a synonym for hydrolysable tannins, which are widely distributed in nature. Tannic acid is used as a flavoring agent and is far more widespread aids in beer clarification, aroma compound in soft drinks and juices. Tannic acid is authorized under directive 2001/83/EC on the community code relating to products for human use for the treatment of mild diarrhea, inflammation of oral mucosa and skin and hemorrhoids. Adult ruminants can tolerate levels of hydrolysable tannins in feed in the range 20000 mg/kg feed without any detectable loss in performance characteristics, whether measured as growth or milk production (Frutos *et al*. 2004; Liu, 2013). Pre-ruminant calves appear to be more vulnerable to toxicosis, but the concentrations of tannic acid required to elicit clinical symptoms are substantially higher than those proposed for flavor purposes (Plumlee *et al*. 1998). Tannins can be used as chemical feed additive to reduce degradation of proteins in the rumen. The tannin-protein complexes are less soluble and less accessible to proteolytic enzymes at the ruminal pH, thereby slowing the rate of ruminal degradation. Farmatan a natural extracts from chestnut tannin have a significant role in prevention of digestive disorders in domestic animal. It also improves body weight gain and feed conversion efficiency in dairy cows (Dumanovski and Sotosek, 1998).

Bhatta *et al*. (2005) showed significant improvement in body weight gain, calculated energy output as well as milk protein content in animals fed with 7.5% tamarind seed husk in the diet. Tannic acid is a polymer, which is poorly absorbed in the digestive tract (Nakamura *et al*. 2003). Tannic acid is degraded in the gut by bacteria or enzymes and its degradation products are absorbed. There is growing evidence that a moderate tannin level may provide protection against microbial degradation of dietary proteins in the rumen, increase efficiency of rumen microbial protein synthesis and protect ruminants from bloat (Haslam, 1996; Mangan, 1988). On the other hand, high levels of tannins produce adverse effects decreased nutrient utilization and animal productivity, and death (Butter *et al*. 1999). The objective of this study was to evaluate the effect of using different levels of tannic acid on some performance traits and nutrient digestibility and fecal consistency in Holstein dairy calves.

MATERIALS AND METHODS

Diets and animal management

This experiment was carried out at the "Shalamzar" Kian Dairy farm, Chaharmahal and Bakhtiari province, Iran. A total of 20 new born Holstein calves (39±5 kg) were used in this study. The experimental calves were randomly attributed to 4 dietary treatments (5 calves in each box). Calves were fed by colostrum within the first 3 days of birth. After that, they fed milk until 60 days twice daily at the morning and afternoon (4 liter per day from 3 to 25 days and 6 liter per day from 25 to 60 days). The treatments were as follows: 1) basal diet formulated to meet all nutritional requirement of calves according to NRC (2001) and milk without any additive, 2) basal diet and milk supplemented with 4 mg tannic acid/L, 3) basal diet and milk supplemented with 6 mg tannic acid/L and 4) basal diet and milk supplemented with 12 mg tannic acid/L. The feed, water and milk were offered *ad libitum* during the experiment.

Samples and measurements

The calves were weighed every week and on 5, 20, 35 and 60 days of the experimental period using a sensitive digital scale (25 g). Feed intake (FI) was measured daily and feed conversion ratio (FCR) was calculated by dividing feed intake by average daily gain in each group. Samples of fecal were collected in air tight plastic containers and refrigerated until determination of fecal dry matter content. Samples of concentrates, hay and feces were oven dried at 60 ˚C to determine dry matter, ash, crude protein, digestible protein, crude fat, neutral detergent fiber, and starch as described by Jansen *et al*. (2003) using acid insoluble ash as internal marker. Fecal consistency of calves was monitored using the procedure described by Larson *et al*. (1977).

Scoring was as follows: 1= normal; 2= soft to loose; 3= loose to watery; 4= watery, mucous; slightly bloody and 5= watery, mucous.

Statistical analysis

The data were subjected to ANOVA process using PROC ANOVA of SAS software (SAS, 2001) based on a completely random design. The treatments were separated by Duncan's (1995) tests at ($P \leq 0.05$) statistical level. The statistical model used in this trial was as below:

$$Y_{ij} = \mu + T_i + e_{ij}$$

Where:
Y_{ij}: dependent variable for treatment i and individual j.
μ: total average.
Ti: tannic acid level.
e_{ij}: residual effect.

RESULTS AND DISCUSSION

The results of dietary inclusion of different levels of tannic acid on feed intake, body weight gain and feed conversion ratio of dairy calves are shown in Table 1. Feed intake, body weight gain (BWG) and FCR did not affected significantly by different levels of tannic acid compared to the control group. Despite the non-significant effect of tannic acid on BWG and FCR, tannic acid inclusion numerically improved BWG and FCR. Rivera *et al*. (2017) reported that supplementation of tannins promoted dry matter intake, and hence increased average daily gain (ADG) of steers during the finishing phase of feedlot. They mentioned this effect on feed intake independent of the potential tannin effect on metabolizable protein supply. Tannic acid at higher concentrations (5, 10, 15 and 20 g/kg rat diet) has been shown to interfere with iron absorption (Afsana *et al*. 2004). In study of Plumlee *et al*. (1998), calves feed by tannic acid at doses of 4.4-5.5 g/kg showed developed methemoglobinemia.

Stukelj *et al*. (2010) noted that the test diets also included some other organic acids and that the tannic acid diet gave numerically lower values than the basal diet. They suggested that younger animals might be more sensitive to the presence of tannic acid. Lee *et al*. (2010) showed that linear decrease in feed conversion ratio and a linear decrease of daily body weight gain with increasing levels of tannic acid in pigs.

Additionally, Jamroz *et al*. (2009) showed that at concentrations greater than 1000 mg tannic acid from chestnut wood/kg feed, growth rate and feed intake are reduced in a 41-days trial in experimental broilers. In addition, Ehrlich (1999) found that higher tannin content in sorghum had a positive effect on feed intake during finishing phase of fattening pigs.

Table 1 The effect of tannic acid on performance of dairy calves

Variables	Tannic acid (mg/L)				SEM	P-value
	0 (control)	4	6	12		
Feed intake (kg)	37.29	38.30	39.11	38.21	0.154	0.121
Body weight gain (kg)	20.16	21.41	23.74	24.00	1.19	0.092
Feed conversion ratio (FCR)	1.72	1.60	1.67	1.52	0.086	0.058

SEM: standard error of the means.

Wilson (1989) showed that feed intake and egg production were significantly reduced in birds given the highest doses of tannic acid. Waghorn *et al*. (1994) noted that tannins also lower rumen turnover rate as well as digestibility of nutrients which has greater impact on reducing feed intake than decrease palatability. Because tannins are capable of binding with dietary proteins, rendering them less degradable within the rumen (Ben-Salem *et al*. 1999). Growth performance responses to supplemental tannins have been generally attributed to enhancements in intestinal metabolizable protein supply (Waghorn, 1996). Pre-ruminant calves appear to be more vulnerable to toxicities, but the concentrations of tannic acid required to elicit clinical symptoms are substantially higher (more than 1 500 mg/kg feed) than those proposed for flavor purposes (Plumlee *et al*. 1998). Table 2 shows that nutrient digestibility of ether extracts (EE) increased by tannic acid treatment. Although organic matter (OM), crude protein (CP), non fiber carbohydrates (NFC), acid detergent fiber (ADF) and neutral detergent fiber (NDF) were increased by using different levels of tannic acid, but also there weren't significant differences for among treatments in comparison to the control.

Additionally different levels of tannic acid had changed nutrient digestibility in treated Holstein calves. In spite of that, found increased *in vitro* dry matter and nitrogen digestibility by adding of tannins.

Also, they showed that tannins protein complexes bind with NDF, ADF and acid detergent lignin (ADL) thereby increase their amount in feces than intake levels thereby showed a negative digestibility. Adult ruminants can tolerate levels of hydrolysable tannic acid in their feed in the range 15000-25000 mg/kg feed without any detectable loss in performance characteristics, whether measured as growth or milk production (Krueger *et al*. 2010). Young animals seem to be more sensitive (>1 500 mg/kg feed) was harmful to calves (Mingshu *et al*. 2006). Bhatt *et al*. (1998) showed that supplemented compounded feed mixture containing 0, 2.5, 7.5% tamarind seed husk with a tannin levels of 0, 0.2 and 0.74% in total diet of cross breed dairy cows at mid lactation had no effect on intake of DM, NDF and ADF and digestibility of major nutrients except protein, which digestibility decreased significantly. Kumar and Singh (1984) showed that tannins could reduce digestibility of the nutrients in the diets. They also mentioned that tannins mainly exert this effect on proteins, but they also affect other feed components to different degrees.

The effect of using different levels of tannic acid on fecal consistency score in treated Holstein calves is shown in Table 3. The results showed that fecal consistency score significantly decreased by adding tannic acid ($P \leq 0.05$). Inclusion of tannic acid in the diet resulted in improved fecal consistency at 0-50 days in all treated calves.

Table 2 The effect of using different levels of tannic acid on some nutrient digestibility

Variable	Treatments				SEM	P-value
	Control	4 (mL/L)	6 (mL/L)	12 (mL/L)		
Ethyl extract (EE)	75.00	76.12	74.24	68.91	3.24	0.70
Organic matter (OM)	66.51	67.71	69.96	74.25	1.63	0.62
Crude protein (CP)	66.90	66.40	68.91	64.20	2.14	0.41
None fiber carbohydrate (NFC)	71.25	74.29	73.00	72.94	0.81	0.35
Acid detergent fiber (ADF)	47.55	48.90	54.22	52.55	2.23	0.76
Neutral detergent fiber (NDF)	51.90	52.22	57.68	53.00	1.41	0.50

SEM: standard error of the means.

Table 3 The effect of using different levels of tannic acid on fecal consistency score

Variable	Treatments				SEM	P-value
	Control	4 (mL/L)	6 (mL/L)	12 (mL/L)		
0-50 days	1.82^{a}	1.44^{ab}	1.47^{ab}	1.22^{b}	0.174	0.015

The means within the same row with at least one common letter, do not have significant difference (P>0.05).
SEM: standard error of the means.

Some researchers showed that the ingestion of tannic acid caused constipation and can be used to treat diarrhea (Allegrini and Costantini, 2010; Morinaga *et al*. 2005). There is plenty of evidence to support the anti-diarrheal effect of medicinal plants found to be rich in tannins (Haslam, 1996; Palombo, 2006). In addition Oliveira *et al*. (2010) showed that feeding some polyphones could affect nutrient digestibility and fecal consistency in calves. Previous studies by Field (2003) have shown that polyphenols and polyphenol derived compounds or alkaloids may act on the biochemical mediators that activate vasodilatation and production of exudates in the intercellular compartments of the intestines.

CONCLUSION

We concluded that inclusion of different levels of tannic acid powder could have beneficial on feed intake, increasing body weight gain and better feed conversion ratio in Holstein dairy calves. Additionally it could be effective on nutrient digestibility and especially improved fecal consistency in experimental Holstein dairy calves. Therefore, a better understanding of tannic acid properties, metabolism and its influence on efficiency of nutrient utilization in early ruminant and dairy calves ration is important. Also more studies are needed for more explanation.

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