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Effect of Feeding Pistachio Byproduct on Performance and Blood Metabolites in Holstein Dairy Cows

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ABSTRACT

The objective of this study was to determine effects of feeding dried pistachio byproduct (DPB) with two source of supplemental protein (soybean meal (SBM) and canola meal (CM) on performance in early lactation of multiparous Holstein dairy cows. The dietary treatments were two levels of dried pistachio by product (0 vs. 10. %. of DM) with two source of protein SBM vs. CM. Dry matter intake, milk yield and composition were not influenced by the DPB and source of protein. No differences were observed between treatments for rumen pH but effect of source of protein on N-NH_3 was significant ($P<0.05$). Apparent total digestibility of dry matter (DM), neutral detergent fiber, acid detergent fiber and crude proteins was similar between treatments. Serum glucose of DPB fed cows was lesser than those not DPB fed. Blood urea nitrogen was affected by the source of protein. Blood urea nitrogen of SBM fed cows was greater than those CM fed. It was concluded that feeding DPB (10% of DM) no effect on performance of dairy cows and could be regarded as feed stuff for regions having low rainfall and forage. © 2010 Friends Science Publishers

Key Words: Pistachio by-product; Soya bean meal; Canola meal; Dairy cows

INTRODUCTION

Low rainfall and availability of water resources for agricultural consumption are the main obstacles to Iranian farmers. Water shortage and dry climatical conditions have increased the costs of animal production in Iran as in many other countries. Limited availability of forage for grazing ruminants and feed shortage for the animals with low-productivity are the other well-known characteristics of the Iran᾽s animal industry (Statistical Center of Iran, 2007). Therefore, it is logical that attempts be made to utilized agricultural and agro-industrial byproducts or residues obtained after crop harvesting or processing of fruit, vegetables and nuts such as Pistachio byproducts (PB) for overcoming the problem.

Iran is the largest pistachio (nuts) producer in the world, as about 58% of the total pistachio dry nuts are produced here. Soon after pistachio harvesting, the nuts must be de-hulled and their moisture content reduced to less than 10% (called as pistachio byproducts; PB). Every year up to 400 tons PB is produced in Iran, which product can be deteriorated in open fields because of its high content of moisture. Thus it can be an environmental pollutant. Therefore, PB utilization as animal feed not only will meet the feed shortage but also reduce the risk of environmental pollution. Crude protein (CP), fiber and fat contents of PB are similar to the almond byproducts, but phenolic compounds of PB are 5-7 times more than almond byproducts (Labavitch *et al*., 1982). The feeding value of PB varies largely depending on variations in pistachio cultivars, harvesting, kernel maturity growing, drying and de-hulling processes. Tannins can affect nutrients utilization by animals (Reed, 1995). Total phenols and total tannins as tannic acid equivalents contents of the sundried PB were 15.2 and 9.0%, respectively (Bagheripour *et al*., 2008). Which precipitate dietary proteins in the rumen. The tannin: protein complex is insoluble at pH 3.5-7, but is soluble and release protein at pH<3.5 (Jones & Mangan, 1977).

There is no report on the effects of pistachio byproduct on the performance of dairy cows. Because PB contains the high level of phenolic compounds and tannins, this study was conducted to evaluate possible effects of dried PB with two source of protein on performance and blood metabolites in Holstein dairy cows.

MATERIALS AND METHODS

Eight multiparous Holstein cows were used in a replicated 4 × 4 Latin square design arranged in a 2 × 2 factorial. Cows averaged 38±15 days into milk (±SD) and produced 35±5 kg of milk daily. Body weights of the cows averaged 638±54 kg at the beginning of the study. Cows were housed in a tie-stall barn and fed individually. Rubber matters were used as bedding. Cows were milked third daily at 0400, 1200 and 2000 h in a milking parlor and were allowed access to an outside concrete area daily after morning milking when the cows were not in collection period. All cows had free access to drinking water

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throughout the trial. Experimental periods were 21-d (14 days for treatment adaptation and 7 days for data collection). Treatments were two levels of DPB (0 & 10% dry matter basis) with two source of protein: SBM and CM. Ingredient and nutrient compositions of the experimental diets are shown in Table I. All diets were formulated to be isonitrogenous to meet the National Research Council (2001) recommendations for crude protein (CP), Ca, P, NaCl and vitamins A, D and E of a 600-kg multiparous cow producing 40 kg of milk per day. Diets were fed as a total mixed ratio (TMR), with rations of forage to concentrate 38:62. Cows were fed *ad libitum* twice daily at 800 and 2000 h in equal portions.

Feed, orts and fecal samples were collected during collection period, dried at 60°C for 72- h and composited for later analysis. Samples were ground to pass through a 1-mm screen using a Wiley mill (Arthur H. Thomas Co., Philadelphia) and analyzed for dry matter (DM), CP (AOAC, 2000), acid detergent fiber (ADF) and neutral detergent fiber (NDF) (Van Soest *et al.*, 1991). Total phenolics, tannins and condensed tannins of DPB were determined following the procedures of Makkar *et al.* (1992).

Milk Yield was weighed and recorded automatically (Metatron P21) at each dried at 60°C for 72 h and composited for later analysis milking. Milk samples were collected during the collection period from three consecutive milking and analyzed for milk CP, fat and lactose with a Milko-Scan 605 analyser (Foss Electric, Hillerød, Denmark). Rumen fluid was collected through a suction-strainer on day 20 beginning at 0900, was dosed intra-ruminally 2 h after feeding on day 20. Approximately 100 mL of rumen fluid was taken to measure pH (Model 2000 pH meter; Beckman, West Chester, Philadelphoa); then fluid was placed in a plastic bag and stored ̃(20□C) for ammonia analysis. Blood samples were collected from each animal at the end of experiment via jugular vein 2 h after mornining feeding and later centrifuged at 3000 × g for 10 min. obtained plasmas were stored at −20°C for later analysis.

All data were analyzed using the fit model procedure of SAS 9.01 according to the following model:

$$Y_{ijk}= \mu+S_i+C_j+P_k+F_l+D_m+(F\times D)_{lm}+e_{ijklm}$$

Where:

μ = overall mean, S_i = random effect of squar (i= 1to 2), C_j = random effect of cow (j = 1 to 8), P_k = fixed effect of period (j = 1 to 4), F_l = fixed effect of source of protein (k = 1 to 2), D_m= fixed effect of pistachio by product, (F×D) = fixed effect of interaction of F_l and D_m and, e_{ijklm} = residual, assumed to be normally distributed.

RESULTS

Effect of DPB and source of protein on dry matter intake (DMI) was non significant (P>0.05; Table II), averaging 20.52, 21.02, 20.67 and 20.90 kg/day, respectively. Milk yield, Fat and protein also did not differ between treatments, averaging 34.05 (kg/d), 3.65 and 3.1%, respectively. Effect of DPB and source of protein on DM, NDF, ADF and CP digestibility were not significant (p> 0.05; Table III). Rumen pH did not differ between treatments, but effect of source protein on rumen ammonia was significant (P<0.05; Table IV). Cows fed SBM had higher ammonia than CM fed cows.

Effect of DPB on serum glucose was significant (P<0.05; Table IV). Cows fed the DPB had lower serum glucose than cows not fed DPB and effect of source protein was not significant. Blood urea nitrogen (BUN) was affected by source of protein (p<0.05; Table IV). Cows fed SBM had greater BUN than cows fed CM. Serum triglyceride did not differ between treatments but cows fed the DPB had lower serum triglyceride compare to control. Creatinine and potassium (K) of serum did not differ between treatments (p> 0.05; Table IV).

Table I: Ingredients and nutrient composition of experimental diets (%DM)

Diet ingredients (%)	SBM		CM	
	DPB	CS	PB	CS
Alfalfa Hay	18	18	18	18
Corn silage	20	10	20	10
Pistachio byproduct	0	10	0	10
Soybean meal	20	19	0	0
Canola meal	0	0	25.5	24
Dry ground corn	14	14	14	14
Barly grain	14	14	14	14
Wheat bran	10	11	4.6	6.1
Calcium carbonat	0.7	0.7	0.7	0.7
Mineral and vitamin mix	1	1	1	1
Vegetable oil	2	2	2	2
Salts	0.3	0.3	0.3	0.3
Dry matter	61.62	73.51	61.60	74.18
Net energy lactation (Mcal/Kg of DM)	1.56	1.65	1.54	1.66
Crude protein %	17.62	17.70	17.65	17.58
Non fiber carbohydrate%	42.82	43.59	40.80	41.67
Neutral detergent fiber%	30.44	28.86	32.75	31.54
Acid detergent fiber%	17.93	16.62	20.31	18.90
Calcium%	0.9	0.9	1	1
Phosphorus%	0.5	0.5	0.5	0.5
Ether extract%	4.2	4.5	5	5.2

SBM= soybean meal, CM= canola meal, DPB= dried pistachio by-product, CS= corn silage, Mineral- vitamin mix provided (g/kg of premix): Ca, 150; P, 100; Mg, 20; Na, 320; Zn, 6; Mn 4; Vitamin B_1, 400; in (IU/ kg of premix)

DISCUSSION

Total phenols and total tannins of pistachio byproducts in this experiment were 9.6 and 4.5%, respectively. Bagheripour *et al.* (2008) reported that total phenols and total tannins as tannic acid equivalents contents of the sundried PB were 15.2 and 9.0%, respectively. Concentration of tannin in diet that influenced DMI had 2% of DM Kumar *et al.* (1984). Because of concentrations of tannin in this study was lesser than 2% of DM, DMI did not differ. Milk yield and composition did not differ between

Table II: Treatment effects on DMI, milk production and composition

Item	SBM		CM			P-value		
	CS	DPB	CS	DPB	SEM	SP	DPB	SP×DPB
DMI (kg/d)	20.52	21.02	20.67	20.90	0.6	0.97	0.45	0.78
Milk yield (kg/d)	34.57	34.14	33.94	33.55	1.14	0.19	0.91	0.53
FCM (4%) (kg/d)	33.52	32.08	31.38	32.04	1.32	0.47	0.92	0.45
Fat %	3.8	3.6	3.5	3.7	0.08	0.37	0.49	0.28
Protein %	3.1	3.1	3.2	3.1	0.17	0.87	0.94	0.91
Lactose %	4.4	4.5	4.4	4.5	0.09	0.06	0.85	0.36

Table III: Treatment effects on total nutrient digestibility

Item (%)	SBM		CM			P-value		
	CS	DPB[c]	CS	DPB	SEM	SP	DPB	SP×DPB
Dry matter	61.50	61.36	64.09	62.42	2.68	0.66	0.16	0.17
Neutral detergent fiber	51.96	52.05	51.85	49.33	4.29	0.41	0.16	0.15
Acid detergent fiber	49.18	48.05	49.87	47.18	4.27	0.57	0.33	0.07
Crude protein	72.36	73.04	72.15	70.13	2.13	0.07	0.06	0.06

Table IV: Treatment effects on rumen fermentation characteristics and blood metabolites (mg/dL)

Blood characteristics	SBM		CM			P-value		
	CS	DPB	CS	DPB	SEM	SP	DPB	SS× DPB
pH	6.54	6.54	6.63	6.55	0.11	0.57	0.65	0.72
Ammonia nitrogen	15.99	14.20	13.33	10.16	1.56	0.04	0.13	0.66
Glucose	49.5	42.54	49.37	47.95	2.18	0.26	0.05	0.26
Blood urea nitrogen	21.12	20.37	15.87	15.62	0.77	0.001	0.47	0.71
Triglyceride	9.50	7.75	9.37	7.75	0.62	0.92	0.92	0.21
Creatinine	1.06	0.96	0.88	0.97	0.04	0.09	0.89	0.05
Potasium	4.53	4.51	4.68	4.18	0.23	0.71	0.28	0.32

SBM= soybean meal, CM= canola meal, CS= corn silage, DPB= dried pistachio by-product; SEM= standard error of means, SP= source of protein

treatments, because there is positive relationship between DMI and milk yield, as observed by Harris *et al.* (1998), Woodward *et al*. (1999), while Wang *et al.* (1996c) reported that milk secretion, lactose and protein were increased during mid and late lactation. In both studies feed intake were not influenced and suggested that increasing milk production induced by condensed tannin.

Apparent total digestibility of DM, NDF, ADF and CP did not differ. Similar results were observed by Utley *et al.* (1993); West *et al.* (1993). Chiquette *et al.* (1989) have reported that, feeding 0.1, 0.2, 0.3 and 0.75% tannin (on DM basis) had no effect on digestibility of DM, NDF and ADF. However, others have found that digestibility of crude protein decreased (MacBrayer *et al.,* 1983). This controversy could possibly be attributed to the nature of tannin and its concentration. Tannins through associate with the bacterial cell surface such as cell-bound extra-cellular enzymes, inhibiting their activity and follow then decreased digestibility and DMI, but extent of the inhibition may differ with different types of tannin.

Greater rumen ammonia in cows fed SBM than in those fed CM may be attributed to degradation of SBM (Kumar & Singh, 1984; Utley *et al*., 1993; West *et al.*, 1993). Lesser serum glucose and greater BUN in cows fed SBM with DPB may be attributed to effect of tannin in DPB on rumen bio-hydrogenation, tannins combine with cell wall structure and inhibition enzymes action could be reduced soluble carbohydrate (Barry & Manley, 1986). BUN concentration has positive relationship with dietary CP intake, its ruminal degradability and resultant ruminal ammonia concentration in cattle Broderick and Clayton (1997), Lahakare *et al*., (2006). Because of degradability of SBM is higher than CM, it is likely that synchronization protein and energy were not sufficient.

We concluded that the performance of animals fed DPB with soybean meal was similar to that of animals fed CM and replacing DPB with corn silage (10% of DM) had no effect on the performance of Holstein dairy cows.

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