Assiut Vet. Med. J. Vol. 43 No. 85, April 2000

Dept. of Animal Prod.
Fac. of Agric., Assiut Univ., Assiut, Egypt

THE EFFECT OF TANNIN ON MILK YIELD AND SOME BLOOD CONSTITUENTS IN DAIRY CATTLE

(With 4 Tables)

By

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(Received at 14/2/2000)

تأثير التانين على إنتاج اللبن وبعض مكونات الدم في ماشية اللبن

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استهدفت الدراسة اختبار تأثير التانين على إنتاج اللبن ، وبعض مكونات الدم ووظائف الكبد متمثلة في (إنزيمي AST , ALT) في ماشية اللبن . استخدم في هذه الدراسة عدد ١٦ بقرة حلابة قسمت طبقا لإنتاجها من اللبن إلى مجموعتين بكل منها عدد ٨ حيوانات. المجموعة الضابطة (٨ حيوانات) غذيت بدون اضافه التانين اما مجموعة التجربة (٨ حيوانات) فقد اضيف إلي غذائها التانين بواقع ٤٠٥جم لكل بقرة يوميا . غذيت الحيوانات على عليقه من المواد المركزة والخشنة طبقا لإحتياجاتها الحافظة والإنتاجية لمدة ٢ أسبوع كفترة تمهيدية و ٤ اسابيع فترة تجريبية. سجل إنتاج اللبن يوميا وأخذت عينات الدم كل أسبوع لتقدير بعض مكونات الدم. وجد ان إضافه التانين إلى الغذاء أدى إلى زيادة ($p<0.01$) إنتاج اللبن إلي ٢٥,٢٦ مقارنة ب ٢٣,٩ كجم في اليوم بالنسبة للمجموعة الضابطة مع تحسن إنتاج اللبن بحوالي ٩% و كان محتوي مصل الدم من الجلوكوز والبروتين الكلى والألبيومين والجلوبيولين يميل إلى الإنخفاض في الحيوانات المعاملة بالتانين. ليس هناك تأثير للمعاملة بالتانين على كل من أنزيمي AST , ALT بينما كان هناك إرتفاع طفيف في محتوى المصل من اليوريا – نيتروجين. وفي الخلاصة فإن إضافة التانين يوميا إلى العليقة المركزة بمعدل ٤٠٥ جم لكل بقرة يوميا لمده ٤ أسابيع أدى إلى تحسن إنتاج اللبن ولم يظهر له أي أثر سيء على مكونات الدم المختبرة وكذلك وظيفة الكبد في ماشية اللبن.

SUMMARY

The objectives of this study were to examine the effects of tannin on milk yield, blood metabolites and liver function (AST and ALT enzymes) in dairy cattle. A total number of 16 dairy cows were allotted according to their milk production ,number of lactation and days in milk to two treatment groups, 8 animals in each. A control group receiving no tannin supplement and a tannin - treated group receiving supplemental dietary hydrolizable tannin, added daily to the concentrate part of the diet at 405 g per cow. All animals were fed a concentrate and roughage diet to cover their requirements for maintenance and production, during 6 weeks "2 weeks preliminary and 4 weeks experimental periods". Milk yield was recorded daily and blood samples were taken every week for determination of some blood constituents, serum glucose, urea-nitrogen, total protein, albumin, globulin, AST and ALT. Dietary tannin increased ($p<0.01$) milk yield (25.26 vs. 23.09 kg/d). Daily milk yield was improved by about 9%. Serum concentrations of glucose, total protein, albumin and globulin tended to be lower in tannin - supplemented animals. No significant differences were observed in the levels of AST and ALT enzymes between control and tannin - treated animals. Serum urea-nitrogen slightly increased due to tannin addition. It was concluded that daily addition of tannin to the concentrates at 405 g per cow improved daily milk yield without any deleterious effects on some blood metabolites, serum glucose, urea-nitrogen, total protein, albumin and globulin, and liver function (AST and ALT) in dairy cattle.

Keywords: Dairy cattle, tannin, blood.

INTRODUCTION

High producing cows consume high dietary protein, however due to the physical limitation of feed intake by the rumen and a high nutritional cost, nutritionists included the animal protein in-the diet to maximize dietary protein. The use of such rations may be/or the cause of mad-cow disease which has occurred in the U.K and elsewhere. An other method to maximize dietary protein in cow's ration is dietary tannin. Tannin is a water-soluble bio - active natural organic compound of plant origin (Lacks, 1989). Tannin protects dietary protein from hydrolysis in

the rumen by forming insoluble complexes with protein (Spencer et al., 1988). This complex is easily broken down in acidic condition (Hagerman and Butler, 1989), consequently may increase the protein digestion and amino acid availability in the small intestine. Recently, dietary bypass protein and/or products containing rumen undegradable protein have improved balance of digestible amino acids in the intestine which increase milk production (Kudrna, et al., 1997). West et al. (1993) found that the increase of groundnut skins (containing 18 % crude protein and 18.7 % tannin) in the diet increased dry matter (DM) intake and milk and fat corrected milk (FCM) yields quadratically, and increased both milk and FCM per DM intake linearly. Only limited information is available about the effect of tannin on ruminants. Therefore the objective of this study was to evaluate the effects of hydrolyzable tannin on milk yield, some blood metabolites and liver function (serum aspartic aminnotrasferase, AST and alanin aminotransferase, ALT enzymes).

MATERIAL and METHODS

Animals and diet:

The present experiment was conducted on 16 dairy cows (Braunvieh and Flickvich). The animals were maintained at an experimental farm, Veterinary Medicine University, Vienna, Austria. All animals were fed on roughages and concentrate diet according to their body weight and milk production (NRC, 1987). Animals were fed and milked twice daily at 4 a.m. and 4 p.m. They had free access water. Animals were fed a control diet free from tannin supplement for 2 weeks as a preliminary period. At the end of that period, they were divided into two groups of 8 animals each. Both groups had similar milk yield, number of lactation and days in milk. A control group receiving no tannin supplements and a tannin - treated group receiving supplemental dietary hydrolyzable tannin, added daily to the concentrate part of the diet at 405 g per cow (about 2.7 % of feed DM). The amount of tannin was calculated on the basis of the maximal protein escaped from degradation in the rumen as 27 g tannic acid equivalent /kg of DM in lactating dairy cows (Broderick, 1995).

Sampling and analytical methods

Milk yield was recorded daily. Blood samples were obtained from all animals at the start of the experiment, then every week during

the experimental period (4 weeks). Samples were collected by jugular veinpuncture "2 hr after morning feed" then allowed to clot at room temperature and serum was then separated by centrifugation "for 15 minutes" and decanted into clean dry plastic vials and stored at -20°C until analyzed. Serum urea-nitrogen, albumin and alanin aminotransferase enzyme (ALT) were determined using kits supplied by Diamond Diagnostics (Egypt). Serum asparatic aminotransferase (AST) concentration was determined using kit supplied by Sclavo Diagnostics (Italy). Serum total protein and glucose concentrations were determined using kits supplied by Biocon (Germany). Serum globulin concentration was calculated from the difference between serum total protein and albumin concentrations.

Statistical analysis:

Data of milk yield and serum constituents were analyzed using general linear model (GLM) procedure of SAS (1982).

RESULTS and DISCUSSION

Milk yield:

Table 1 shows that dietary tannin significantly ($p<0.01$) increased overall mean milk yield (25.26 vs 23.09 kg/day). Daily milk yield improved by about 9, 5, 12 and 13 % at the first, second, third and fourth week of the experimental period, respectively. The overall mean of milk yield was improved by about 9 % due to tannin treatment (Table 1). Hydrolyzable tannins form insoluble complexes with proteins in the rumen, thus making them hardly digestible. It is assumed that this complex is released at a low pH (below 2.5) in the abomasum, therefore a larger proportion of the protein and amino acids arrives the small intestine (Jansman and Longstaff, 1993). This causes an increase of post - ruminal digestion and/or an increase of the amounts of nutrients; particularly amino acids available for absorption, this may be the main cause of icreased milk yield in tannin - treated animals. For this reason, Ishigaki et al. (1994) found that when milk production level was about 25 kg, milk yield of cows fed 17 % crude protein (CP) diets were increased more than those of cows fed 14% CP diets. In addition, Barry et al. (1986) found that high tannin - containing plants increased plasma growth hormone (GH) concentration in sheep. Kensinger et al. (1998) found that milk yields of cows treated with bovine GH improved by about 17 %.

Table 1: Daily milk yield (kg) as influenced by dietary tannin in dairy cattle

Experimental week	Control	Tannin	S.E. of LSM
1	24.34 [a]	26.41 [b]	0.58
2	24.20 [a]	25.33 [b]	0.58
3	22.29	24.94	0.58
4	21.54 [a]	24.35 [b]	0.58
Overall mean	23.09 [a]	25.26 [b]	0.29

Values are least - squares means (LSM) and SE = standard error of LSM.
Treatments: control = animals receiving no tannin supplement, Tannin = animals receiving supplemental dietary hydrolyzable tannin, 405 g per cow daily.
a, b ($p<0.01$).

Metabolites:

The results shown in Table 2 indicate that added tannin on a level of 405 g per animal and day decreased overall mean serum glucose concentration. However the effect was only significant at the third week of the experimental period. This result may be connected with the increase in milk production of tannin - treated animals (Table 1). Oldenbroek et al. (1997) found that a higher milk yield was accompanied with lower plasma glucose concentration. Furthermore, propionate concentration in rumen liquor decreased significantly due to tannin supplementation using rumen simulation technique (Kobeisy et al. 1999). Propionic acid is the only one of the volatile fatty acids produced by rumen fermentation that is a major source of glucose and over 90 % of the absorbed propionate is removed from the portal blood by the liver (Bergman, 1983). In animals fed large amounts of concentrates, or otherwise grossly overfed, propionate probably can account for two-thirds of the total glucose produced (Bergman, 1983). The overall serum urea-nitrogen concentration was slightly higher in tannin - supplemented animals than in controls. However, dietary tannin increased ($p<0.01$) the serum urea-nitrogen by about 20 % at the fourth week of the experimental period (Table 2). Similarly, Zhu and Filippich (1995) found that the plasma urea concentration was significantly elevated 48 hr after abomasal administration of tannic acid to adult Marino ewes.

Table 2: Serum glucose and urea-nitrogen concentrations (mmol/l) as influenced by dietary tannin in dairy cattle

Experimental week	Glucose			Urea-nitrogen		
	Control	Tannin	SE	Control	Tannin	SE
0	2.20 [a]	3.89 [b]	0.35	3.39	3.51	0.33
1	2.32	1.97	0.35	2.98	2.96	0.33
2	2.44	2.06	0.35	3.51	3.40	0.33
3	3.06 [c]	1.87 [d]	0.35	3.16	4.37	0.33
4	3.61	2.68	0.35	3.22 [a]	3.87 [b]	0.33
Overall mean	2.72	2.49	0.16	3.25	3.59	0.15

Values are least - squares means (LSM) and SE = standard error of LSM.
Treatments: control = animals receiving no tannin supplement, Tannin = animals receiving supplemental dietary hydrolyzable tannin, 405 g per cow daily.
a, b ($p<0.01$); c,d ($p<0.05$)

The overall means of serum total protein, albumin and globulin concentrations were slightly lower in tannin - supplemented animals than in controls. Such decrease in total protein and globulin was significant ($p<0.01$) at the fourth week of the experimental period (Table 3). Similarly, Zhu and Filippich (1995) found that plasma total protein concentrations significantly decreased 24 hr after abomasal dosing of tannic acid in sheep. Low serum total protein of tannin-supplemented animals may be due to the increase of protein uptake as a result of the increase in milk production of treated animals (Table 1). In addition, the decrease of serum protein concentrations of tannin - supplemented animals may be related to that dietary tannin increased growth hormone (Barry et al., 1986). This hormonal response results in a decreased plasma concentration of amino acids (Riis, 1983).

Table 3: Serum total protein, albumin and globulin concentrations (g/dl) in dairy cattle as influenced by dietary tannin

Experimental	Total protein			Albumin			Globulin		
Week	Control	Tannin	SE	Control	Tannin	SE	Control	Tannin	SE
0	6.43	7.16	0.40	4.09	3.40	0.17	2.67	3.75	0.44
1	7.06	7.03	0.40	4.04	3.69	0.17	3.02	3.34	0.44
2	7.79	8.02	0.40	4.29	3.88	0.17	3.50	4.14	0.44
3	8.13	7.47	0.40	4.50	4.04	0.17	3.63	3.42	0.44
4	8.40 [a]	6.70 [b]	0.40	3.92	4.31	0.17	4.49 [a]	2.39 [b]	0.44
Overall mean	7.64	7.28	0.18	4.17 [a]	3.86 [b]	0.08	3.46	3.41	0.20

Values are least - squares means (LSM) and SE = standard error of LSM.
Treatments: control = animals receiving no tannin supplement,
Tannin = animals receiving supplemental dietary hydrolyzable tannin,
405 g per cow daily. a,b ($p<0.01$).

Serum Transaminases (AST and ALT):

The overall means of serum aspartate aminotransferase (AST) and alanin aminotransferase (ALT) concentrations were slightly lower in tannin-supplemented animals than those in controls, however such differences were insignificant (Table 4). The level of aspartate aminotransferase (AST) or L- alanine aminotransferse (ALT) in serum have some value as indicators of liver damage because of their high content in liver (Radostits et al. 1995). Low level of transaminases (AST and ALT) indicate normal tissue destruction and subsequent enzyme release (Coles, 1985). Zhu et al. (1992) found that liver lesions are produced by oral dosing with tannin in mice but not in sheep.

Table 4: Serum aspartic aminotransferase (AST) and alanin aminotransferase (ALT) concentrations (u/l) as influenced by dietary tannin in dairy cattle.

Experimental	AST			ALT		
Week	Control	Tannin	SE	Control	Tannin	SE
0	59.39	67.39	6.25	9.46[a]	6.34[b]	0.73
1	62.15	64.97	6.25	7.14	5.60	0.73
2	61.86	50.82	6.25	7.48	6.09	0.73
3	56.50	50.57	6.25	6.23	6.47	0.73
4	55.12	50.87	6.25	6.62	8.12	0.73
Overall mean	59.00	56.92	2.79	7.38[c]	6.52[d]	0.32

Values are least - squares means (LSM) and SE = standard error of LSM.
Treatments: control = animals receiving no tannin supplement,
Tannin = animals receiving supplemental dietary hydrolyzable tannin, 405 g per cow daily. a, b ($p<0.01$); c,d ($p<0.06$)

In conclusion: the addition of hydrolyzable tannin added daily to concentrate diet at 405g per cow raised significantly milk production (by 2.17 kg/head/day) without any deleterious effects on the tested blood metabolites and liver function (AST and ALT) in dairy cattle.

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