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Influence of tannins supplementation on growth performance, dietary net energy and carcass characteristics of yearling steers fed finishing diet containing dried distillers grains with solubles

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Supplemental tannin has improved daily weight gain and gain efficiency in feedlot cattle (Barajas *et al*. 2010, 2011) owing to decreased ruminal protein degradation, resulting in greater metabolizable amino acids supply (Min *et al.* 2003), and the decreased methane production (Goel and Makkar 2012). However, with conventional feeding practices, limitations on metabolizable amino acid supply in feedlot cattle is unlikely except during the receiving and initial growing phases (Zinn and Shen 1998, Zinn *et al*. 2007). The effects of supplemental tannins on mitigation of methane production were observed in cattle fed high fiber diets (Woodward *et al*. 2004, Puchala *et al.* 2005), whereas conventional feedlot finishing diets have a minimal fiber (8–9% forage in diets; Vasconcelos and Galyean *et al*. 2007). Nevertheless, in recent years increased amounts of dry distiller grains with solubles (DDGS) were incorporated into finishing diets as a partial replacement for grain. Due to the high fiber content of DDGS, this replacement resulted in increased methane production as a proportion of digestible energy intake (Luebbe *et al*. 2011, Carrasco *et al*. 2013). There is limited information on the effects of tannins supplementation on growth performance and carcass characteristics of yearling cattle fed finishing diets contained DDGS. The objective of the present experiment was to determine the effect of tannins supplementation on growth performance, dietary energetics and carcass characteristics in yearling steers fed a finishing diet containing DDGS. Finishing diets containing 15% of DDGS were fed to 150 crossbred steers for 152-d experiment following all procedures involving animal care and management were in accordance with and approved by the University of California, Davis, Animal Use and Care Committee.

Cattle originated from southeast Texas and were received at the University of California Desert Research Center, El Centro. Upon arrival, cattle were vaccinated for bovine rhinotracheitis-parainfluenza$_3$, clostridials, treated for parasites, injected subcutaneously with 500,000 IU vitamin A, and 1,200 mg ceftiofur , branded, ear-tagged, and implanted with Revalor-IS. Bull steers were castrated and horns, if present, were tipped. During initial 49-d adaptation period all steers were fed receiving and transition diets. On d 28 of the transition period steers weighed and given their vaccine booster shots. Steers were then blocked on day 28th by weight and randomly assigned within weight groupings to 30 pens, 5 steers/pen and 10 pens/treatment. Subsequently, all steers received the same basal finishing diet (Control diet, Table 1) for 14 d prior to initiation of the experiment which lasted 152 days. Pens were 78 m^2 with 33 m^2 of overhead shade, automatic waterers, and fence-line feed bunks. Dietary treatments consisted of a steam-flaked corn-based growing-finishing diet (Table 1) supplemented with 0, 0.32, and 0.64% CT (70% condensed tannin;CT) which correspond to 0, 2.2 and 4.4 g of condensed tannins/kg DM. Diets were prepared at weekly intervals and stored in plywood boxes located in front of each pen. Steers were allowed *ad lib.* access to experimental diets. Fresh diet was provided twice daily. Feed and refusal samples were collected daily for DM analysis, which involved oven drying the samples at 105°C until constant weight (method 930.15, AOAC 2000). Fifty days after experiment began, all steers were again injected subcutaneously with 500,000 IU vitamin A and implanted with Revalor-S.

For estimation of dietary net energy, energy gain (EG) was calculated by the equation: EG = ADG$^{1.097}$ 0.0557W$^{0.75}$, where EG, daily energy deposited (Mcal/d); W, mean shrunk BW (kg; NRC 1984). Maintenance energy (EM) was calculated by the equation: EM = 0.077W$^{0.75}$ (NRC 1984). Dietary NE$_g$ was derived from NE$_m$ by the equation: NE$_g$ = 0.877 NE$_m$ - 0.41 (Zinn 1987). Dry matter intake is related to energy requirements and dietary NE$_m$ according to the equation: DMI = EM/NE$_m$ + EG/(0.877NE$_m$ - 0.41), and can be resolved for estimation of

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Table 1. Experimental fed to steers

	Supplemental tannin,% DM basis		
	0	0.22	0.44
Steam-flaked corn	63.15	62.83	62.51
DDGS	15.00	15.00	15.00
Sudangrass hay	12.00	12.00	12.00
Molasses cane	5.00	5.00	5.00
Yellow grease	2.50	2.50	2.50
Urea	0.95	0.95	0.95
Limestone	1.50	1.50	1.50
Magnesium oxide	0.12	0.12	0.12
Trace mineral salt[1]	0.30	0.30	0.30
ByPro[2]	0	0.32	0.64
Rumensin 90, g/ton	157	157	157
Nutrient composition (DM basis)[3]			
NE, Mcal/kg			
Maintenance	2.19	2.19	2.19
Gain	1.53	1.53	1.53
Crude protein,%	14.3	14.3	14.3
Calcium,%	0.70	0.70	0.70
Phosphorus,%	0.36	0.36	0.36
Potassium,%	0.82	0.82	0.82
Magnesium,%	0.28	0.28	0.28
Sulfur,%	0.18	0.18	0.18

[1]Trace mineral salt contained: $CoCO_3$, .043%; $CuSO_4$, 0.67%; $FeSO_4$, 0.67%; $ZnSO_4$, 2.71; $MnSO_4$, 2.23%; KI, .044%; and NaCl, 93.63%. [2]70% condensed tannin (SilvaFeed, Indunor, S.A., Buenos Aires, Argentina). [3]Based on tabular values for individual feed ingredients (NRC, 2000).

dietary NE by means of the quadratic equation: $x = [-b - (b^2\text{-}4ac)^{0.5}]/2c$, where $x = \text{NE}_m$, $a = -0.41$ EM, $b = 0.877$ EM + 0.41 DMI + EG, and $c = -0.877$ DMI (Zinn and Shen 1998).

Hot carcass weights (HCW) were obtained at time of slaughter. After carcasses chilled for 48 h, the following measurements were obtained: *Longissimus* muscle (LM) area (cm^2) by direct grid reading of the LM at the 12th rib; subcutaneous fat (cm) over the LM at the 12th rib taken at a location 3/4 the lateral length from the chine bone end (adjusted by eye for unusual fat distribution); Kidney-pelvic-hearth fat (KPH) as a percentage of HCW; marbling score (USDA 1997; using 3.0 as minimum slight, 4.0 as minimum small, 5.0 as minimum modest, 6.0 as minimum moderate, etc.), and estimated retail yield of boneless, closely trimmed retail cuts from the round, loin, rib and chuck (% of HCW; Murphey *et al.* 1960) = 52.56 - 1.95 × subcutaneous fat - 1.06 × KPH + 0.106 × LM area - 0.018 × HCW.

All performance and carcass data were analysed as a randomized complete block design. The experimental unit was the pen. The MIXED procedure of SAS (SAS Institute 2004) was used to analyze variables. The fixed effect consisted of treatment, and pen as the random component. Treatment effects were tested for linear, quadratic and cubic components of the tannins supplementation level. Contrasts are considered significant when the P-value was ≤0.05, and tendencies are identified when the P-value was > 0.05 and ≤0.10.

Table 2. Effects of tannins supplementation on growth performance of feedlot steers and net energy (NE) value of the diet

	Supplemental tannin,%				Contrast P-value	
Item	0	0.22	0.44	SEM	Linear	Quadratic
Days on test	152	152	152			
Pen replicates	10	10	10			
Live weight, kg [1]						
Initial	312	313	313	0.38	0.12	0.36
84-D	465	460	469	2.89	0.42	0.05
Final	584	575	585	5.35	0.88	0.17
ADG, kg						
1 to 84 d	1.83	1.75	1.86	0.03	0.54	0.03
84 to 152 d	1.75	1.70	1.71	0.05	0.65	0.62
1 to 152 d	1.79	1.73	1.79	0.03	0.97	0.14
DMI, g/d						
1 to 84 d	8.38	8.19	8.70	0.13	0.09	0.04
84 to 152 d	9.13	9.47	9.78	0.23	0.06	0.95
1 to 152 d	8.72	8.76	9.19	0.16	0.05	0.34
ADG/DMI, kg/kg						
1 to 84 d	0.219	0.215	0.214	<.01	0.20	0.59
84 to 152 d	0.192	0.180	0.175	<.01	<0.01	0.36
1 to 152 d	0.206	0.198	0.195	<.01	<0.01	0.26
Dietary NE, Mcal/kg						
Maintenance						
1 to 84 d	2.13	2.20	2.17	0.02	0.14	0.94
84 to 152 d	2.44	2.30	2.27	0.03	<0.01	0.15
1 to 152 d	2.32	2.25	2.22	0.02	<0.01	0.35
Gain						
1 to 84 d	1.53	1.52	1.49	0.02	0.14	0.94
84 to 152 d	1.73	1.60	1.58	0.03	<0.01	0.15
1 to 152 d	1.63	1.56	1.54	0.02	<0.01	0.35
Observe to expected dietary NE ratio						
Maintenance						
1 to 84 d	1.01	1.00	0.99	0.01	0.14	0.94
84 to 152 d	1.11	1.05	1.04	0.01	<0.01	0.15
1 to 152 d	1.06	1.03	1.01	0.01	<0.01	0.35
Gain						
1 to 84 d	1.00	0.99	0.98	0.01	0.14	0.94
84 to 152 d	1.13	1.05	1.03	0.02	<0.01	0.15
1 to 152 d	1.06	1.02	1.00	0.01	<0.01	0.35

[1] Initial and final live weights reduced 4% to account for fill.

Tannin supplementation did not affect (P = 0.97) daily gain weight gain (ADG), averaging 1.77 kg (Table 2). Tannin supplementation increased (linear effect, P <0.01) dry matter intake (DMI). This effect was particularly notable during the final 68 d of trial. Increases in DMI has been a consistent response in feedlot cattle fed supplemental tannin. In a 226-d study, Barajas *et al*. (2011) observed a 6% increase on DMI in bull (initial body weight= 184 kg) fed a growing-finishing diet supplemented with 0.34% of a blend of condensed and hydrolyzable tannins. Likewise, in a 140-d trial, Tabke (2014) observed a linear increasing in DMI of feedlot bulls fed a finishing diets supplemented with 0, 0.3 or 0.6% of blend of condensed and hydroyzable tannin. Likewise, tannin supplementation increased DMI in goats

Table 3. Effects of tannins supplementation on carcass characteristics

Item	Supplemental tannin,%				Contrast P-value	
	0	0.22	0.44	SEM	Linear	Quadratic
Pen replicates	10	10	10			
Carcass weight, kg	377	370	374	3.49	0.64	0.24
Dressing percentage	64.5	64.3	63.9	0.31	0.20	0.81
Longissimus area, cm^2	95.7	94.5	94.3	1.85	0.61	0.84
Fat thickness, cm	1.20	1.24	1.33	0.07	0.25	0.75
KPH,%[1]	2.46	2.48	2.47	0.06	0.83	0.89
Retail yield,%[2]	50.7	50.7	50.3	0.34	0.41	0.79
Quality grade[3]	4.74	4.69	5.04	0.20	0.30	0.44

[1]Kidney, pelvic, and heart fat as a percentage of carcass weight.

[2] Estimated retail yield of boneless, closely trimmed retail cuts from the round, loin, rib and chuck (% of HCW; Murphey *et al.* 1960)

[3] Marbling score (USDA, 1997; using 3.0 as minimum slight, 4.0 as minimum small, 5.0 as minimum modest, 6.0 as minimum moderate, etc.).

(Puchala *et al.* 2005), lambs (Douglas *et al.* 1995), and lactating cows (Woodward *et al.* 2000).

Whereas, the increased DMI with tannin supplementation was not accompanied by increased ADG and gain efficiency whereas estimated dietary NE decreased (linear effect, $P < 0.01$). These findings were not of consistent with our expectation that tannin supplementation might enhance energetic efficiency through a potential decrease in acetate:propionate molar ratio (Beauchemin *et al*. 2007) and methane energy loss (Goel and Makkar 2012). The basis for a decrease in gain efficiency and dietary NE with tannin supplementation is not certain and require further research.

There were no treatment effects on carcass characteristics ($P>0.20$; Table 3). Similarly, supplemental tannin (at 0, 0.21 or 0.42% condensed tannins) did not change the carcass characteristics of crossbred steers following a 150-d finishing period (Tabke 2014). Supplementation of 20.8 g/kg DM of chestnut hydrolysable tannins have not influenced carcass characteristics in lambs during finishing (Frutos *et al.* 2004). Whereas, in a short-term 42-d finishing study, Krueger *et al.* (2010) observed that tannin supplementation decreased carcass weight of feedlot steers, it did not affect other measures of carcass characteristics.

It is concluded that the tannins supplementation did not enhance growth performance of yearling steers fed a high-energy finishing diet containing 15% DDGS, and may decrease efficiency of energy utilization.

SUMMARY

Finishing diets containing 15% DDGS with 0, 0.22, and 0.44% condensed tannin did not affect average daily gain, but linearly increased dry matter intake. Tannin supplementation linearly decreased gain efficiency, and estimated dietary NE. Carcass characteristics were not affected by tannin supplementation. Therefore, tannins supplementation did not enhance growth performance of yearling steers fed a high-energy finishing diet containing 15% DDGS, and may decrease efficiency of energy utilization.

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