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Utilization of tanniniferous feeds. 7. Effect of supplementation of *Acacia nilotica* pods on mineral balances in crossbred cattle

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ABSTRACT

Male crossbred (Karan Fries and Karan Swiss; body weight 205 to 233 kg) cattle (12) were grouped into 4 of 3 each in a randomized block design to determine the effect of *Acacia* pods on mineral balances. *Acacia* pods were used at different levels in concentrate mixture (0, 31, 62 and 93%). Dry matter intake (kg/d) was 5.92±0.16, 5.70±0.30, 5.47±0.37 and 5.17±0.70 in 0, 31, 62 and 93% *Acacia* pods supplemented groups respectively. Dry matter intake was not affected by inclusion of *Acacia* pods up to 62% in the concentrate mixture, but reduced thereafter. Calcium balance was increased up to 62% level of inclusion of *Acacia nilotica* pods in the concentrate mixture and decreased thereafter. However, phosphorus balance was unaffected with increased level of *Acacia nilotica* pods up to 62% in the concentrate mixture but reduced thereafter. Magnesium balance reduced with increased level of *Acacia nilotica* pods in the ration. Balance of Zn (mg/d) in treatment groups reduced significantly compared to control group. Copper balance (mg/d) reduced with increased level of pods in the concentrate mixture. Similarly, cobalt balance was lower in *Acacia* pods supplemented groups. Reduction in balances of Mg, Zn and cobalt were more pronounced as compared to copper with increased level of *Acacia* pods in the concentrate mixture. It can be inferred that *Acacia nilotica* pods beneficially improved the calcium balance while did not affect phosphorus balance up to 62% inclusion of *Acacia* pods, however, reduced the availability of magnesium, zinc, cobalt and copper in crossbred cattle.

Key words: *Acacia* pods, Calcium, Copper, Cobalt, Mineral balance, Magnesium, Phosphorus, Zinc

The use of agro-industrial byproducts for economic ration formulation has been coming up rapidly due to unavailability of quality feed. Moreover, easy availability at cheaper rate amplified their use as animal feeds. However, presence of anti-nutritional factors in most of agro-industrial byproducts limits their use as animal feeds. Tannin is one of such anti-nutritional factors (McLeod 1974, Hagerman *et al.* 1992, Barman and Rai 2000, 2003, 2004, 2006b, Alam *et al.* 2007, Krebs *et al.* 2007) which inhibits the nutrient utilization and animal productivity. *Acacia nilotica* is one of such tannin containing highly nutritious fodder trees. Annual availability of *Acacia* pods in India is about 600000 tonnes (Punj 1988). *Acacia* pods are available in almost all states of India. *Acacia* pods contain 18.7% tannin (Barman and Rai 2006a). *Acacia* pods contain quite a good source of all the essential amino acids (Kumaresan *et al.* 1974, Barman and Rai 2006a).

Scanty information is available about the effect of *Acacia* pods on mineral availability in dairy cattle. Therefore, present study was carried out to find out the effect of *Acacia* pods on mineral balances in crossbred cattle.

MATERIALS AND METHODS

Male crossbred (Brown Swiss × Sahiwal; Holstein Friesian × Tharparker; body weight ranged from 205 to 223 kg) cattle (12) were divided into 4 groups of 3 animals each in a randomized block design. They were housed in a well-ventilated byre. The animals were daily brushed and washed with tap water throughout the experimental period. Animals were fed to meet the nutrient requirement as per the NRC (1989). The 4 groups of animals were fed on 4 different concentrate mixtures namely 1, 2, 3 and 4 whose composition (w/w) include: maize grain–36, 11, 14, 0; wheat bran–43, 49, 13, 0; groundnut cake–21, 9, 11, 7 and *Acacia* pods–0, 31, 62, 93% respectively. Additionally 2% mineral mixture and 1% salt were added in each concentrate mixture. Besides this 1.0% ferrous sulphate was added to the diets 3 and 4. The animals were grouped into 4 groups and fed on experimental diet T_1, T_2, T_3 and T_4 as follows

T_1 (Control, 0% tannin) : Concentrate mixture 1 + oat hay (70:30 ratio)

T_2 (4% tannin group) : Concentrate mixture 2 + oat hay

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(70:30 ratio)

T_3 (8% tannin group) : Concentrate mixture 3 + oat hay (70:30 ratio)

T_4 (12% tannin group) : Concentrate mixture 4 + oat hay (70:30 ratio)

A preliminary period of 20 days feeding of experimental diets was conducted before starting the trial. The metabolic trial was conducted for 6 days. Body weights of the animals were taken for 2 consecutive days before and after the trial. All the animals were supplemented with 1 kg of green maize fodder each to meet the vitamin A requirement.

Daily feed offered and residue left were recorded to determine the net feed intake. First day collected faeces and urine were discarded. Faeces and urine voided during 24h were recorded and daily representative amount was brought to laboratory for aliquoting. A known amount (1/200th part) of representative faecal sample was taken in pre-weighed dried aluminium tray for determination of dry matter voided in faeces. After determination of dry matter, dried faecal sample from each animal was pooled for 6 days. For N determination, 1/200th of the total faeces voided was kept in a pre-weighed plastic container and then known quantity of 25% H_2SO_4 was added. Similarly, 1/200 part of the total urine voided was kept in separate bottle and known quantity of H_2SO_4 was added. For mineral estimation, a known amount (1/200 parts) was taken in clean amber colour glass bottle and few ml toluene was added as preservative. In this way 6 days samples of faeces and urine from each animal were pooled together and these were used for estimation of chemical composition, nitrogen balance and mineral balance.

Feed and faeces were ground to pass through 1mm sieve. Proximate principles were estimated according to the procedure of AOAC (1990) and fibre constituents were estimated as per the procedure of Goering and VanSoest (1970).

For mineral estimation, 1g feed was digested in 100 ml Kjeldahl flask containing glass beads to avoid bumping at very low heat initially by adding adequate amount of triacid mixture (HNO_3:$HClO_4$:H_2SO_4–2.5:1:1 ratio) and then at higher temperature till the contents are clear and perchloric acid ($HClO_4$) fumes decreased to come out. The final volume was made to 25 ml and filtered to remove silica and other insoluble residues from digested samples.

Ca, Mg, Co, Cu, Mn, Zn was estimated with the help of atomic absorption spectrophotometer using acetylene as fuel and air as oxidant. Specific hollow cathode lamp was used for each mineral.

Phosphorus content in sample was estimated by phosphomolybdovandate complex formation method (AOAC 1990).

RESULTS AND DISCUSSION

Chemical composition of diet and nutrients intake by crossbred cattle

Organic matter content of the concentrate mixture varied from 89.69 to 90.78% in concentrate mixture (Table 1). Crude

Table 1. Chemical composition of experimental diet and the effect of supplementation of *Acacia* pods on nutrient intake in crossbred cattle

Parameters	Diets				CD
	T_1 (0% *Acacia* pods)	T_2 (31% *Acacia* pods)	T_3 (62% *Acacia* pods)	T_4 (93% *Acacia* pods)	
Chemical composition					
OM,%	90.78±0.36	89.71±0.03	90.36±0.35	89.69±0.19	
CP,%	17.12±0.62	16.43±0.05	15.46±0.52	16.24±0.38	
CF,%	10.90±0.68	12.29±0.55	14.59±0.40	15.95±0.52	
NFE,%	58.39±1.67	58.52±0.21	56.82±0.79	55.26±0.30	
Ca,%	0.89	1.28	1.28	1.83	
P%	1.46	1.13	1.28	0.85	
Mg%	0.65	0.6	0.63	0.5	
Zn, ppm	284.25	355.25	277.00	234.25	
Cu, ppm	0.45	0.40	0.38	0.45	
Co, ppm	0.10	0.08	0.05	0.05	
Nutrient intake					
Body weight, kg	237.3±5.0	224.2±11.7	223.7±15.1	215.5±29.1	23.11^{NS}
DMI, kg/d	5.92^{a}±0.16	5.70^{a}±0.30	5.47^{ab}±0.37	5.17^{b}±0.70	0.56*
DCP intake, g/d	543.81^{a}±22.39	479.20^{a}±28.28	304.55^{b}±36.31	304.30^{b}±58.18	79.24**
TDN intake, kg/d	4.26^{a}±0.19	4.06^{ab}±0.23	3.81^{b}±0.33	3.65^{b}±0.53	0.42*

OM, organic matter; CP, crude protein; EE, ether extract; CF, crude fibre; NFE, nitrogen free extracts; DMI, dry matter intake; DCP, digestible crude protein; TDN, total digestible nutrient; CD,critical difference; Different superscript ^{a,b,c,d} (*$P<0.05$; **$P<0.01$) in a row differ significantly; NS, nonsignificant; T_1, concentrate mixture 1: oat hay:: 70:30; T_2, concentrate mixture 2: oat hay:: 70:30; T_3, concentrate mixture 3: oat hay:: 70:30; T_4, concentrate mixture 4: oat hay:: 70:30; Oat Hay contains 90.29±0.20, 4.87±0.10, 46.44±0.18, 37.94±0.41% OM, CP, CF and NFE, respectively, and 3.20, 0.05, 0.25% and 175.00, 0.23, 0.08 ppm Ca, P, Mg, Zn, Cu and Co respectively.

protein content of the concentrate mixture ranged from 15.46 to 17.12%. The organic matter, crude protein and nitrogen free extract contents of oat hay were 90.29, 4.87 and 37.94% respectively. Calcium content increased and phosphorus content reduced in the concentrate mixture with increased level of pods (Table 1). Magnesium, copper, cobalt and zinc of the concentrate mixtures were almost similar across all levels of supplementation of *Acacia* pods (Table 1). Calcium, phosphorus, magnesium of the oat hay were 3.28, 0.05, 0.25%, respectively, while copper, cobalt and zinc content were 0.23, 0.08 and 175.0 ppm respectively (Table 1).

Dry matter intake was reduced with increased level of pods in the diet ($P<0.05$) although there was no difference in intake in groups 1, 2 and 3 but reduced significantly ($P<0.05$) in group 4, which was due to astringent property of pods. Similarly reduction in digestible crude protein intake ($P<0.01$) and total digestible nutrient intake ($P<0.05$) was observed with increased level of pods in the ration (Table 1).

Mineral balances

Calcium intake (g/d) was higher ($P<0.01$) in *Acacia* pods supplemented group compared to control (Table 2). In spite of low DMI, higher Ca intake in *Acacia* pods supplemented groups were due to high Ca content (0.34%) of *Acacia* pods. Major route of Ca excretion was through faeces. Average Ca balance (g/d) was significantly higher in groups 2 and 3 in comparison to 1 and 4, which indicates that *Acacia* pods tannin at lower level (4%) beneficially improved Ca balance by increasing the absorption of Ca.

Singh (1979) reported that inclusion of sal seed meal @ 45% (5.75% tannin) in the concentrate mixture of lactating buffaloes reduced Ca balance. However, Rai and Shukla (1977) did not find any effect on Ca balance when sal seed meal was supplemented @ 10 and 20% in the concentrate mixture of lactating cows. Ally and Kunjikutty (2003) found positive Ca balance in goat fed on tree leaves containing 3.4 and 5.5% tannin.

Phosphorus intake unaffected up to 31% inclusion of pods in the concentrate mixture but reduced thereafter, due to both low DMI ($P<0.05$) and high level of *Acacia* pods, which contained low phosphorus (Table 2). Major route of phosphorus excretion was through urine rather than faeces. However, excretion of phosphorus through urine decreased ($P<0.01$) and faeces increased ($P<0.01$) with increasing levels of *Acacia* pods, which may be due to binding of phosphorus to tannin. Total excretion (g/d) of phosphorus was decreased ($P<0.01$) with increased level of *Acacia* pods in the diet. Probably the tannin of *Acacia* pods helps in chelation of phosphorous resulting in lower excretion, thus balance remained similar in groups 1, 2 and 3 (Table 2).

In contrary to the present findings, reduction in P balance was reported by Singh (1979) in lactating buffaloes fed on diet containing 45% sal seed meal equivalent to 5.75% tannin while Rai and Shukla (1977) did not find effect on P balance in cattle fed on 10 and 20% sal seed meal. The nature of tannin present in a particular feed varies from one species to another. *Acacia* pods contain an uncommon type of tannin e.g. epigallocatechin gallate (Ayoub 1985) as well as catechin

Table 2. Effect of supplementation of *Acacia* pods on calcium and phosphorus balances in crossbred cattle

Parameters	Diets				SEm	CD
	T_1 (0% *Acacia* pods)	T_2 (31% *Acacia* pods)	T_3 (62% *Acacia* pods)	T_4 (93% *Acacia* pods)		
Calcium						
Ca intake, g/d	$92.88^{a}\pm2.65$	$105.23^{ab}\pm5.44$	$101.81^{ab}\pm7.15$	$115.46^{b}\pm15.19$	6.30	18.26**
Faecal Ca, g/d	$34.44^{a}\pm2.94$	$22.99^{a}\pm7.07$	$34.71^{a}\pm11.53$	$54.99^{b}\pm14.63$	7.11	13.23*
Urinary Ca, g/d	$3.18^{a}\pm0.43$	$3.83^{a}\pm0.85$	$4.59^{a}\pm2.14$	$10.19^{b}\pm1.90$	1.07	3.09**
Total Ca outgo, g/d	$37.61^{a}\pm2.90$	$26.82^{a}\pm7.73$	$39.30^{a}\pm12.45$	$65.17^{b}\pm12.96$	6.98	20.22**
Ca balances, g/d	$55.27^{a}\pm0.70$	$78.41^{b}\pm4.10$	$62.51^{cd}\pm7.56$	$50.29^{ad}\pm8.35$	2.42	12.28**
Absorbed Ca, g/d	$58.44^{a}\pm0.39$	$82.24^{b}\pm3.26$	$67.09^{a}\pm7.91$	$60.48^{a}\pm9.50$	4.52	13.08**
Absorbed Ca as% intake	$63.04^{a}\pm2.11$	$78.63^{b}\pm5.48$	$66.81^{a}\pm9.68$	$53.29^{a}\pm7.61$	4.82	13.95**
Phosphorus						
P intake, g/d	$61.83^{a}\pm1.59$	$58.33^{a}\pm3.23$	$49.52^{b}\pm3.28$	$32.25^{c}\pm4.64$	2.38	6.88**
Faecal P, g/d	$4.10^{a}\pm0.31$	$4.19^{a}\pm0.34$	$7.29^{b}\pm1.15$	$5.81^{b}\pm0.70$	0.50	1.46**
Urinary P, g/d	$20.96^{a}\pm8.97$	$16.84^{ab}\pm7.06$	$7.91^{bc}\pm3.43$	$2.44^{c}\pm1.29$	4.23	12.26**
Total P outgo, g/d	$25.05^{a}\pm8.68$	$21.03^{a}\pm6.76$	$15.19^{ab}\pm3.93$	$8.25^{c}\pm1.73$	4.17	12.08**
P balances, g/d	$36.77^{a}\pm9.81$	$37.30^{a}\pm8.55$	$34.33^{a}\pm2.04$	$24.00^{b}\pm3.04$	4.77	8.57*
Absorbed P, g/d	$57.73^{a}\pm1.53$	$54.14^{a}\pm2.98$	$42.25^{b}\pm3.43$	$26.44^{c}\pm4.01$	2.21	6.39**
Absorbed P as% intake	$63.25^{a}\pm16.47$	$68.28^{ab}\pm13.57$	$82.04^{bc}\pm7.61$	$91.64^{c}\pm3.68$	8.13	14.60*

Ca, calcium; P, phosphorus; SEm, standard errors of mean; CD, critical difference; Different superscript ^{a,b,c,d} (*$P<0.05$; **$P<0.01$) in a row differ significantly; T_1, concentrate mixture 1: oat hay:: 70:30; T_2, concentrate mixture 2: oat hay:: 70:30; T_3, concentrate mixture 3: oat hay:: 70:30; T_4, concentrate mixture 4: oat hay:: 70:30.

Table 3. Effect of supplementation of *Acacia* pods on magnesium and zinc balances in crossbred cattle

Parameters	Diets				SEm	CD
	T_1 (0% *Acacia* pods)	T_2 (31% *Acacia* pods)	T_3 (62% *Acacia* pods)	T_4 (93% *Acacia* pods)		
Magnesium						
Mg intake, mg/d	$1259.66^a \pm 40.72$	$1132.94^b \pm 75.64$	$1116.98^b \pm 91.47$	$889.11^c \pm 151.38$	56.59	105.26*
Faecal Mg, mg/d	611.64 ± 89.83	625.17 ± 75.53	598.91 ± 139.40	628.92 ± 154.77	68.81	127.99^{NS}
Urinary Mg, mg/d	$98.94^a \pm 7.18$	$72.11^b \pm 24.52$	$139.07^c \pm 7.30$	$115.99^c \pm 15.15$	8.80	16.37*
Total Mg outgo, mg/d	$710.58^{ab} \pm 96.33$	$697.28^a \pm 54.47$	$844.39^b \pm 186.81$	$744.91^{ab} \pm 162.18$	78.00	145.08*
Mg balance, mg/d	$549.08^a \pm 93.92$	$435.66^b \pm 44.48$	$378.70^b \pm 51.57$	$144.20^c \pm 10.84$	33.53	97.12**
Absorbed Mg, mg/d	$648.02^a \pm 86.74$	$507.77^b \pm 59.94$	$518.07^b \pm 58.43$	$260.19^c \pm 12.35$	34.87	101.00**
Absorbed Mg as% intake	$51.48^a \pm 6.86$	$44.88^a \pm 5.07$	$47.08^a \pm 8.47$	$30.37^b \pm 6.23$	3.90	11.29**
Zinc						
Zinc intake, mg/d	$2400.99^a \pm 77.50$	$1749.81^b \pm 116.43$	$1363.89^c \pm 112.42$	$1132.78^d \pm 192.84$	75.82	219.56**
Faecal zinc, mg/d	895.44 ± 125.65	861.01 ± 116.77	881.02 ± 86.39	922.02 ± 169.46	73.72	137.12^{NS}
Urinary zinc, mg/d	$17.24^a \pm 8.53$	$12.00^a \pm 0.76$	$8.69^b \pm 0.80$	$18.26^a \pm 1.77$	2.53	7.32**
Total zinc outgo, mg/d	912.67 ± 127.04	873.01 ± 117.46	889.71 ± 87.18	940.28 ± 171.12	74.40	85.08^{NS}
Balances, mg/d	$1488.32^a \pm 60.81$	$876.80^b \pm 98.15$	$474.18^c \pm 61.36$	$192.50^d \pm 90.34$	45.74	132.47**
Absorbed zinc, mg/d	$1505.55^a \pm 56.00$	$888.80^b \pm 98.14$	$482.87^c \pm 61.53$	$210.76^d \pm 90.98$	45.35	131.34**
Absorbed zinc as% intake	$62.87^a \pm 4.18$	$50.87^b \pm 5.33$	$35.22^c \pm 3.43$	$18.21^d \pm 6.43$	2.86	8.29**

Mg, Magnesium; SEm, standard errors of mean; CD,critical difference; Different superscript ^{a,b,c,d} (*P<0.05; **P<0.01) in a row differ significantly; T_1, concentrate mixture 1: oat hay:: 70:30; T_2, concentrate mixture 2: oat hay:: 70:30; T_3, concentrate mixture 3: oat hay:: 70:30; T_4, concentrate mixture 4: oat hay:: 70:30.

gallate, the nature of which differ from other types of tannin (Self *et al.* 1986) as evident in the present study.

Magnesium intake (mg/d) decreased (P<0.05) with increased level of *Acacia* pods in the diet. Faecal excretion was similar in all groups (Table 3). However, urinary excretion increased (P<0.05) with increased level of *Acacia* pods in the diets. This indicates that tannins of *Acacia* pods bind Mg and increased their excretion through urine, which results in increased total out go (mg/d) in *Acacia* pods-supplemented groups compared to control. Magnesium balance (mg/d) was reduced (P<0.01) in groups supplemented with *Acacia* pods in comparison to control. Absorption of Mg (mg/d) and absorbed Mg as% of intake was significantly reduced (P<0.01). It is evident that tannin of *Acacia* pods even as low as 4% in the diet (31% *Acacia* pods in the concentrate mixture) reduced Mg balance by reducing its absorption. However, tannin at a concentration of 0.06% in the diet of rat did not affect Mg balance as reported by Sotohy *et al.* (1997).

Zinc intake (mg/d) was significantly lower (P<0.01) with increasing level of *Acacia* pods in the diet. This was due to both lower DMI and low Zn content of *Acacia* pods (Table 3). Urinary excretion did not follow a set pattern like that of Ca, P and Mg. However, faecal excretion (mg/d) insignificantly increased with increased levels of *Acacia* pods in the diets. Although intake was low at higher inclusion levels of *Acacia* pods, total outgo (mg/d) did not differ among treatments. As a result of high excretion of Zn in faeces and low intake at higher level of *Acacia* pods lead to low (P<0.05) balance (mg/d) of Zn in pods supplemental groups in comparison to control. Similarly, absorbed Zn (mg/d) and absorbed Zn as% intake were low (P<0.01) in treatment groups because of low (P<0.01) Zn content in treatment groups as well as of low intake and higher faecal excretion of Zn in comparison to control.

Copper intake (mg/d) was lower (P<0.01) in *Acacia* pods supplemented groups compared to control. However, Cu intake in *Acacia* pods-supplemented groups was similar (Table 4). Lower intake of Cu in supplemented groups was mainly due to low DMI. Similar Cu intake, in spite of lower DMI with increased levels of *Acacia* pods was due to high Cu content of *Acacia* pods. Similar to Ca, P and Mg; excretion of Cu through urine also decreased (P<0.01) and faecal excretion increased. Total excretion (mg/d) was similar across all groups. Copper balance (mg/d) was lower (P<0.05) in *Acacia* pods supplemented groups compared to non-supplemented group. Absorbed Cu (mg/d) as well as% intake of Cu was low (P<0.01) in all groups supplemented with *Acacia* pods in comparison to control group. It may be due to both low DMI as well as insignificantly higher faecal excretion.

Similar to Ca, P, Mg, Zn and Cu; intake of Co was also low (P<0.01) in *Acacia* pods supplemented groups in comparison to control because of low DMI as well as low Co content of *Acacia* pods (Table 4). Faecal excretion was increased (P<0.01) while urinary excretion was decreased (P<0.05) with increased levels of *Acacia* pods in the diets. Probably the tannin of *Acacia* pods is responsible for more Co excretion through faeces than through urine, which results in similar net excretion across all supplemented groups.

Table 4. Effect of supplementation of *Acacia* pods on copper and cobalt balances in crossbred cattle

Parameters	Diets				SEm	CD
	T_1 (0% *Acacia* pods)	T_2 (31% *Acacia* pods)	T_3 (62% *Acacia* pods)	T_4 (93% *Acacia* pods)		
Copper						
Cu intake, mg/d	$2.28^a±0.07$	$1.99^b±0.13$	$1.83^b±0.15$	$2.01^b±0.34$	0.12	0.22*
Faecal Cu, mg/d	1.14±0.13	1.23±0.13	1.25±0.12	1.24±0.26	0.10	0.18^{NS}
Urinary Cu, mg/d	$0.10^a±0.01$	$0.12^a±0.01$	$0.08^b±0.01$	$0.06^b±0.01$	0.01	0.02**
Total Cu outgo, mg/d	1.24±0.12	1.35±0.13	1.33±0.13	1.30±0.27	0.10	0.19^{NS}
Cu balance, mg/d	$1.04^a±0.11$	$0.65^b±0.16$	$0.50^c±0.03$	$0.71^b±0.21$	0.08	0.15*
Absorbed Cu, mg/d	$1.14^a±0.11$	$0.77^b±0.16$	$0.58^b±0.03$	$0.77^b±0.21$	0.08	0.24**
Absorbed Cu as% intake	$50.01^a±5.01$	$38.28^b±7.15$	$31.58^b±1.59$	$38.11^b±7.27$	3.30	9.56**
Cobalt						
Co intake, mg/d	$0.56^a±0.02$	$0.46^b±0.03$	$0.32^c±0.03$	$0.30^c±0.05$	0.02	0.06**
Faecal Co, mg/d	$0.13^a±0.02$	$0.15^a±0.05$	$0.18^b±0.02$	$0.18^b±0.03$	0.02	0.04**
Urinary Co, mg/d	$0.08^a±0.01$	$0.09^a±0.00$	$0.06^b±0.01$	$0.05^b±0.01$	0.00	0.01*
Total Co outgo, mg/d	0.21±0.02	0.25±0.05	0.24±0.03	0.22±0.04	0.02	0.04^{NS}
Co balance, mg/d	$0.35^a±0.04$	$0.21^b±0.04$	$0.08^c±0.00$	$0.08^c±0.03$	0.02	0.05**
Absorbed Co, mg/d	$0.43^a±0.03$	$0.31^b±0.04$	$0.15^c±0.01$	$0.13^c±0.03$	0.02	0.05**
Absorbed Co as% intake	$76.91^a±4.07$	$67.40^a±5.59$	$45.14^b±3.50$	$41.47^b±5.96$	3.60	10.42**

Cu, Copper; Co, cobalt; SEm, standard errors of mean; CD, critical difference; Different superscript ^{a,b,c} (*$P<0.05$; **$P<0.01$) in a row differ significantly; T_1, concentrate mixture 1: oat hay:: 70:30; T_2, concentrate mixture 2: oat hay:: 70:30; T_3, concentrate mixture 3: oat hay:: 70:30; T_4, concentrate mixture 4: oat hay:: 70:30.

Cobalt balance was lower ($P<0.01$) in *Acacia* pods supplemented groups, because of low DM intake in comparison to control. Probably the tannin of *Acacia* pods reduced ($P<0.01$) the absorption (mg/d as well as of% intake) of Co by means of chelation resulting higher faecal excretion across all levels of pods supplemented groups.

It is concluded that inclusion of *Acacia* pods in the concentrate mixture of crossbred cattle did not affect calcium and phosphorus balances up to 62% inclusion while reduced thereafter. Balances of magnesium, copper, cobalt and zinc were reduced with increased level of *Acacia* pods in the concentrate mixture. Further research is necessary to find out its effect on mineral balances in other species of ruminant.

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