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Influence of monensin on intake of some anti-nutritive components in diets fed to West African dwarf (WAD) goats

R. Y. Aderinboye and C. F. I. Onwuka
Department of Animal Nutrition, College of Animal Science & Livestock Production, University of Agriculture, P. M. B. 2240, Abeokuta, Ogun State, Nigeria
aderinbry@yahoo.com

Abstract

Sixteen (16) West African dwarf goats weighing an average of 7.3 kg ± 1.2 were used in a completely randomized experimental design to determine the influence of feeding monensin on intake of some anti-nutritive components contained in the diet. Results showed that animals placed on monensin-supplemented diets at levels of 15, 30 and 45 mg/kg DM had significantly (P<0.05) reduced intakes of tannin, oxalate, saponin and nitrate compared to those placed on the control diet (0 mg monensin/kg DM). No significant difference (P>0.05) occurred amongst the monensin-supplemented groups. Faecal concentrations of tannin, oxalate, saponin and nitrate were similarly, observed to reduced (P<0.05) with monensin inclusion. However, the percentage disappearance of each of the anti-nutritive components was not altered (P>0.05). Reductions in total dry matter intake were observed in response to monensin supplementation at 15, 30 and 45 mg/kg DM relative to the control but dry matter digestibility and weight gain in animals were not altered. The reductions in the intake of dry matter with monensin feeding were assumed to have consequently caused the reductions in the intake of anti-nutritive components from the diet. This reduction caused by monensin would be of benefit, in a bid to lessen some of the nutritional problems usually encountered when animals consume large quantities of these components in the diet. Monensin inclusion at levels between 15 and 45mg/kg DM could therefore be recommended to alleviate toxicity problems commonly associated with intake of anti-nutritive substances in feed.

Keywords: *Monensin, anti-nutritive components, intake, WAD goats*

Introduction

Anti-nutritive factors are those physical and chemical features of plants potentially available for grazing or browsing which result in lower levels of animal productivity than would be expected from proximate analysis of the foliage (Paterson, 1993). A large number of such compounds found in plants categorized as primary or secondary metabolites essentially serve as defence mechanism for the plant against predators and microbial infection (El Hassan *et al.*, 1995). According to Paterson (1993), they serve to protect the plant from excessive damage by being feeding deterrents to herbivores. There are indications however, that some of them have defaunation qualities, some are bactericidal, others baceteriostatic (Osuji *et al.*, 1995). Several deleterious compounds have been identified in forages and fodder trees including alkaloids, non-protein amino-acids, mycotoxins, terpenoids, steroids, lectins and protease inhibitors. Many of the African browse species contain high levels of polyphenolics and insoluble condensed tannins (Proanthocyanidins) that bind to NDF. Some phenolic compounds are toxic to rumen bacteria, rumen fungi and rumen potozoa. Oxalate and the alkaloid peroline inhibit cellulose degradation by the rumen microbial population (El Hassan *et al.*, 1995). Manifestations of toxicity range from simple reduction of food and nutrient utilization to lethal neurological disorders (D'Mello, 1992). Attempts have been made to harness anti-nutritional factors (e.g. tannins) to nutritional advantage (Osuji *et al.*, 1995). A number of feed additives such as monensin are routinely used in ruminant diets. Monensin is an ionophore antibiotic which acts primarily within the rumen (Macgregor, 1988). Ionophores have been used extensively in the United Kingdom and the United State of America for many years where the main benefit of its use appears to be improved feed conversion (Wilson and Brigstocke, 1981). Various studies with the use of monensin have been carried out and marked effects on animal performance particularly in terms of feed intake and weight gain in ruminants have been observed. However, studies on its effect on antinutritional components in feeds have been rarely conducted. This study examined the influence of ionophore monensin on the intake of some antinutrititive components common in ruminant feeds.

Materials and Methods

This study was conducted in the small ruminant experimental unit at the Teaching and Research Farm of University of Agriculture, Abeokuta, Nigeria. The region is located in the derived savannah vegetation zone of South-Western Nigeria and it falls within latitude 7°5.5'-7°8'N and longitude 3°11.2'- 3°23.5'E. The climatic condition is humid with a mean annual rainfall of 1037mm. The mean annual temperature and humidity are 34.7°C and 82% respectively. A 90 d feeding trial was conducted using Sixteen West African dwarf bucks with pre-trial mean live weight of 7.3 ± 1.2 kg. Animals were de-wormed and checked against ectoparastic infection prior to the commencement of the experiment. The animals were placed individually in cross-ventilated pens with slated floors. Animals were allowed an adaptation period of two weeks prior to the commencement of the trial during which they were maintained on basal diets of *Panicum maximum* and *Gmelina arborea* forages and a concentrate supplement. At the end of the adaptation period, the animals were divided into four groups of four animals each, balanced for body weight and each group of animals was randomly assigned to one of four experimental diets. The basal diet used was *Panicum maximum* and *Gmelina arborea* leaves in the ratio of 60:40 of the total forage requirement. Leaves of both forages were harvested fresh on a daily basis and fed to the animals in a cut-and-carry system. Four concentrate supplements containing monensin at levels of 0, 15, 30 and 45mg/kg dry matter were also compounded (Table1). These formed the treatment diets T_1, T_2, T_3 and T_4 respectively. The concentrate supplement was fed at 30% of the animals' daily feed requirement while the forage diet made up the remaining 70%. Experimental animals were fed at 50g/kg BW with the basal diet offered first to the animals from 8:00 am daily and the concentrate supplement an hour after in separate feeding troughs.

Quantities of feed offered and refused daily per animal per treatment were recorded during the trial to compute feed intake on daily basis. Two animals per treatment were later transferred into individual metabolic cages at the end of the feeding trial. Faecal samples were collected using metabolic cages with provision for separate collection of urine and faeces. A period of 5 days was allowed for adjustment by the animals followed by a 7-day collection period. During the collection period, total faecal output per animal per treatment was measured daily. Aliquots of the daily faecal samples and feeds provided were colleted for each animal and weighed. These samples were later pooled together per animal and oven dried at 65°C to constant weight to determine the dry matter content. Dried samples were then ground with a hammer mill to pass through a 2mm sieve and then bulked properly for subsequent analysis. Compositions of tannin, saponin, oxalate, hydrogen cyanide and nitrate in the feeds and faecal samples collected were determined. Tannin determination was done by spectrophotometer method as described by Daura *et al.* (1988). The A.O.A.C. (1996) method was used for oxalate and saponin determination while HCN was determined using the method of Wood (1965). Nitrate was estimated by the method of Rider and Mellon (1946). The design of the experimental was a completely randomized

Table 1 *Feed composition (g/kg DM) of concentrate diet incorporated with monensin*

Ingredients	T_1	T_2	T_3	T_4
Wheat offal	650.000	649.985	649.970	649.955
Brewers' dried grain	300.000	300.000	300.000	300.000
Bone meal	30.000	30.000	30.000	30.000
Salt	20.000	20.000	20.000	20.000
Monensin	0.000	0.015	0.030	0.045
Total (g)	1000.000	1000.000	1000.000	1000.000
Nutrient Composition (%)				
Dry matter	96.22	95.86	96.14	96.18
Crude Protein	13.68	13.87	14.62	14.97
Organic matter	91.16	90.90	90.85	90.88
Ash	8.84	9.1	9.15	9.12
Neutral detergent fibre	58.16	60.04	59.82	60.17
Acid detergent fibre	39.19	40.62	40.26	40.31
Lignin	9.86	9.74	9.93	9.65

T_1, T_2, T_3 and T_4 represent monensin inclusion levels at 0, 15, 30 and 45 mg/kg of the concentrate diet

design. All statistical data collected in this study were subjected to one-way analysis of variance (ANOVA) using the SAS (1990) procedure. Differences between means were separated by Duncan's multiple range test (Duncan, 1955).

Results and Discussion

Table 2 shows the anti-nutritive components determined in the experimental diets fed to West African dwarf goats. Tannin content of the concentrate supplement at varying levels of monensin inclusion ranged from 0.052 to 0.091 %. Oxalate concentration ranged from 0.049 to 0.061 %, saponin contents were between 0.034 and 0.046 % while nitrate content ranged from 0.425 to 0.440 %. Concentrations of these anti-nutritive components were not significantly different (P>0.05) irrespective of monensin levels. Probable reason for which monensin did not alter the concentration of anti-nutritive components in the diet could be that since monensin has its action site within the rumen (Macgregor, 1988), it would not act outside the rumen environment to alter feed constituent. Hydrogen cyanide was not detected in the concentrate diets fed. For the forage diets, *Gmelina arborea* had tannin content of 0.290 % while Panicum maximum had no traces of tannin concentration. Oxalate concentration for *Gmelina arborea* and *Panicum maximum* forages was 0.660 and 0.042 %, respectively Saponin content was 0.084 and 0.033 % while the nitrate concentration was 1.160 and 0.150 % for *Gmelina arborea* and *Panicum maximum* forages, respectively. Concentrations of anti-nutritive factors in the experimental diets fed to West African dwarf goats were considerably low. The concentration of antinutritional components detected in the diet was within the range which the ruminant animal can cope with, without adverse effect. *Gmelina arborea* had a low content of tannin when compared with other browse species. *Gliricidia sepium* has been reported to have levels of up to 2.05 % (Ahn *et al.*, 1989) while levels of 3 – 14 % have been reported for *Leuceana leucocephala* (D'Mello and Fraser, 1981). Tannin contents reported in this study were below the reported threshold of 4% (Onwuka, 1992) and 5% (McNaughton, 1987). Experimental animals did not show any negative reaction to the levels of tannin in the diet at all treatment levels. *Panicum maximum* was devoid of tannin. This suggests that the presence of tannin is not a common characteristic

Table 2 Concentration (g/100g DM) of anti-nutritive components in experimental diets fed to West African dwarf goats.

Components	Concentrate diets				Forage diet	
	T_1	T_2	T_3	T_4	*Gmelina arborea*	*Panicum maximum*
Tannin	0.091	0.083	0.058	0.052	0.290	0.000
Oxalate	0.061	0.049	0.057	0.050	0.660	0.042
Saponin	0.046	0.036	0.036	0.034	0.084	0.033
Hydrogen cyanide	0.000	0.000	0.000	0.000	0.000	0.000
Nitrate	0.440	0.430	0.435	0.425	1.160	0.150

T_1, T_2, T_3 and T_4 represent monensin inclusion levels of 0, 15, 30 and 45mg/kg of the concentrate diet

Table 3 Dry matter intake, digestibility and weight gain in West African dwarf goats placed on monensin-supplemented diet.

Parameters	T_1	T_2	T_3	T_4	SEM
Total dry matter intake (g/day)	724.80[a]	585.10[b]	571.40[b]	575.10[b]	0.202
Dry matter digestibility (%)	67.94	70.04	71.15	71.66	0.67
Average daily weight gain (g/day)	32.53	37.80	38.86	39.15	1.452
Average initial live weight (kg)	7.23	7.65	7.40	7.00	0.446
Average final live weight (kg)	9.93	10.80	10.63	10.25	0.282

[a, b] *Means along the same row with different superscripts are significantly different (P<0.05)*
T_1, T_2, T_3 and T_4 represent monensin inclusion levels of 0, 15, 30 and 45mg/kg DM of concentrate diet

Table 4 Intake and faecal concentration of some anti-nutritive components in experimental diet fed to West African dwarf goats.

Parameters	T_1	T_2	T_3	T_4	SEM
Tannin intake (g/d)	0.606[a]	0.470[b]	0.409[b]	0.417[b]	0.322
Faecal tannin (g/d)	0.322[a]	0.237[b]	0.209[b]	0.213[b]	1.025
% disappearance	46.87	49.57	48.90	48.92	0.056
Oxalate intake	1.256[a]	0.978[b]	0.944[b]	0.963[b]	0.229
Faecal oxalate	0.657[a]	0.492[b]	0.479[b]	0.478[b]	0.717
% disappearance	47.69	49.69	49.26	50.40	0.067
Saponin intake	0.340[a]	0.257[b]	0.250[b]	0.250[b]	0.909
Faecal saponin	0.216[a]	0.155[b]	0.148[b]	0.150[b]	1.025
% disappearance	36.47	39.69	40.80	40.00	0.048
Nitrate intake	3.149[a]	2.501[b]	2.408[b]	2.471[b]	0.230
Faecal nitrate	1.390[a]	1.170[b]	1.150[b]	1.150[b]	0.718
% disappearance	55.86	53.22	52.24	53.46	0.042

[a, b] *Means along the same row with different superscripts are significantly different (P<0.05)*
T_1, T_2, T_3 and T_4 represent monensin inclusion levels of 0, 15, 30 and 45mg/kg of the concentrate diet

of tropical grasses as it is found prevalent in browse species. The levels of all the other anti-nutritional components found in the diets fed were similarly low and did not impose any observable adverse effect on the experimental animals. Though the presence of these compounds might have been thought to contribute to the reduction in intake of feed dry mater by the animals as shown in Table 3, more so as tannin has been implicated for causing depressions in feed intake and reducing palatability of feeds, probably by causing an astringent or dry feeling in the mouth, or by negatively affecting digestion (Bates-Smith, 1973; Barry and Manley, 1984; Barry *et al.*, 1986; Reed, 1986). However, reduction in dry matter intake observed in this study was not a depression effect of anti-nutritive components present in the diet since animal performance particularly the weight gain was not negatively affected. Reduction in dry matter intake was strongly attributed to monensin inclusion effect more so as the feed efficiency was improved. Table 4 shows the intake of anti-nutritive components from the diet by West African dwarf goats and the faecal concentrations of these components. Monensin inclusion caused a significant reduction ($P<0.05$) in tannin intake from 724.8 g/d at 0 mg of inclusion (control) to between 571.4 - 585.1 g/d with 15 - 45 mg of inclusion. However, animals in the groups supplemented with 15, 30 and 45 mg, showed similarity ($P>0.05$) in the intake of tannin. The amount of feacal tannin voided similarly reduced ($P<0.05$) with monensin inclusion. The intake and feacal concentrations of the other anti-nutritional components measured followed similar patterns decreasing ($P<0.05$) with monensin inclusion in the diet at 15, 30 and 45 mg/kg DM of the concentrate diet. The reduction effect of monensin on the intake of tannin, oxalate, saponin and nitrate (g/d) could be as a result of the reduction in dry matter consumed which consequently led to consumption of lower levels of these anti-nutritive components from the diet. The reduction effect of monensin on dry matter intake, which was assumed to consequently reduce the intake of anti-nutritional components in the diet, is probably a good indication that monensin could possibly help lessen the occurrences of certain toxicities and nutritional problems usually encountered in animals consuming large quantities of these components in feeds, especially in forage species. Such nutritional/toxicity problems include bacteriostatic and bactericidal effects of tannin (Kumar and D'Mello, 1995), reduction in available sulphur, degenerative changes in the intestine, liver, spleen and kidney, and the appearance of mucus in urine and fatal constipation (Kumar and Singh, 1984). The reduction in anti-nutritional components (ANC) voided in faeces is probably a reflection of the reduced intake of these components from the diet. Though monensin had no effect on the percentage disappearance of anti-nutritional components from the diets when fed however, certain proportions of these compounds were observed to be absent from the faeces voided. The proportion of tannin which disappeared from the faeces could be due to possible formation of protein-tannin complexes in the rumen. According to the reports of Reed (1986), tannin-protein complexes formed in the digestive tract were recovered as faecal lignin. The proportion of oxalate and nitrate which disappeared from the faeces voided could be due to microbial degradation oxalate and nitrate. According to McDonald *et al.* (1995), when oxalate is consumed it may be degraded by rumen microorganisms, combine with calcium in the rumen, and be absorbed into the blood stream. Intoxication however occurs when large amounts are absorbed. Similarly, while nitrate itself may not be toxic to animals, it is reduced readily under favourable conditions, as in the rumen, to nitrite, which is toxic (McDonald *et al.*, 1995).

Conclusion and Recommendation

With the reduction effect of monensin on intake of anti-nutritive components from the diet, monensin might be an essential additive for alleviating certain toxicities/metabolic disorders encountered in ruminants feeding on high diets containing anti-nutritive substances. Goats are generally regarded as enthusiastic browsers feeding on trees, twigs and shrubs. Leaves from most of these tree species particularly the browse trees often contain large quantities of ANFs. Therefore, including monensin in the diet for browsing ruminant species particularly goats would be of great importance. While monensin inclusion at 15 – 45 mg/kg DM of concentrate supplement is recommended in diets containing averagely low quantities of ANF, higher levels could be introduced in diets containing higher antinutritive contents. However, use of higher inclusion levels at which a resultant reduction in feed intake would have a negative effect on animal performance should be guided against.

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