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Full Length Research Paper

Effects of *Aspergillus niger* treated Shea butter cake based diets on nutrient intake and weight gain of Red Sokoto goat

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Effects of feed intake, weight gain and digestibility when growing Red Sokoto goats consuming *Aspergillus niger* treated and untreated shea-butter cake (SBC) were determined. Twenty five Red Sokoto goats in a completely randomized design model with 56 d periods consumed diet A (control, without SBC), B (15% *Aspergillus* treated SBC), C (15% untreated SBC), D (7.5% *Aspergillus* treated SBC) and E (7.5% untreated SBC). Total DMI rose (P < 0.05) with *Aspergillus* treated diets (B and D) than the untreated diets (C and E). The trend was similar for the rest of the variables (CPI and EEI) except for the crude fibre intake which did not show a specific trend. Dry matter digestibility for the control diet (A) was the lowest than any of the other diets while the highest dry matter digestibility was recorded for diet D. For the untreated SBC diets (C and E) versus *Aspergillus* treated diets (B and D), crude fibre digestibility, crude protein digestibility and ether extract digestibility were lower for the untreated diets C and E. Liveweight gain was greatest (P < 0.05) for the control diet (A), greater (P < 0.05) for *Aspergillus* treated diets (B and D) than for the untreated diets (C and E) and tended to be (P < 0.05) great for 15% fungus untreated SBC than for diet E (7.5% fungus untreated SBC). Up to 15% of complete diet for Red Sokoto goats can be composed of *Aspergillus* treated SBC with little or no reduction in feed intake, weight gain or digestibility coefficient.

Key words: Feed intake, digestibility coefficient, weight gain, red Sokoto goats.

INTRODUCTION

The nutrition and management of livestock in the tropics is similar to that of the temperate zones if the animals are kept intensively (Smith and Daborn, 1989). However, the lack of availability of feed for the animals mostly during the dry season in the tropics is very marked indeed. The grass available to ruminant animals during the dry season is very poor nutritionally. Hence, there is the need to search for waste agricultural residues which will be available throughout the year and which will not compete with humans for the limited supplies available. Most waste agricultural residues available contain some anti-nutritional factors and high content of lignin which prevents the availability of other nutrients. Kieg and Fox (1978) reported decreased nutrient availability due to some nutrient been bound by some anti-nutritional factors or enzymatically destroy particular nutrients present in feedstuff thereby decreasing their availability. Examples of such nutrients include tannin and saponin. These anti-nutritional factors are present in some feedstuffs like shea butter cake.

Shea butter cake is a by-product of Shea butter industry. The cake which constitutes a nuisance to the environment contains 15.02% CP, 26.00% cellulose, 55.40% acid detergent fibre and 29.30% lignin (Belewu et al., 2004). The presence of such anti-nutritional factors like tannin and saponin could prevent the availability of some nutrients like protein to the animal if not properly processed. Additionally, the cake has bitter taste due to the presence of such factors making the cake to be unpalatable to livestock.

The palatability of the cake and the anti-nutritional fac-

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Table 1. Composition of the experimental diets.

Ingredients (%)	Diet A (0% SBC)	Diet B (15% SBC)	Diet C (15% SBC**)	Diet D (7.5% SBC)	Diet E (7.5% SBC**)
Corn bran	50.00	50.00	50.00	50.00	50.00
Brewer's dried grain	33.00	33.00	33.00	33.00	33.00
Shea-butter cake	0.00	15.00	15.00	7.50	7.50
Soybean cake	15.00	0.00	0.00	7.50	7.50
Bone meal	1.00	1.00	1.00	1.00	1.00
Vitamin-mineral premix	0.50	0.50	0.50	0.50	0.50
Salt	0.50	0.50	0.50	0.50	0.50
Proximate composition of the experimental diets (%)					
Dry matter	93.24	93.05	94.75	95.10	95.20
Crude protein	16.32	17.54	17.37	16.43	15.62
Ether extract	7.92	8.84	9.23	8.27	7.18
Crude fibre	18.60	12.74	13.35	12.41	13.32
Ash	15.75	20.56	20.32	32.90	38.69
Acid detergent fibre	44.94	44.85	40.45	47.55	36.74
Neutral detergent fibre	74.13	60.29	64.90	64.19	71.11
Lignin	21.15	19.60	22.20	19.80	20.10
Cellulose	8.57	8.46	9.66	7.98	8.28
Hemicellulose	35.24	27.17	38.08	38.04	44.94

**Treated Shea-butter cake.

tors of the cake could be improved through various processing methods. Various processing methods used for the treatment of waste agricultural residues are well documented in the literatures. A chemical method for the treatment of waste agricultural residues has been previously reported (Belewu et al., 2004), a physical method was also reported by Mudgett (1986) while a biological method was reported by Belewu and Banjo (1999), Belewu (2006) and Belewu et al. (2007). The effects of treatment of cassava waste, rice husk, sawdust, sorghum stover using *Aspergillus niger, Trichoderma harzanium* and mushroom on feed intake, apparent digestibility, blood, carcass and organ measurements were reported with encouraging results (Belewu and Banjo, 1999; Belewu and Adenuga, 2003; Belewu and Jimoh, 2005). *A. niger* was reported to possess tannin–protein complex degrading activity (Bhat et al., 1996). The fungus was reported to have degrading effects on 5-methyl resoranol or 3,5-dihydroxytoluene, and was reported to be capable of degrading a variety of aromatic compounds like salicylate resorcinol, benzoate, chlorobenzoates, phenoxyacetate and chloro-phenoxyacetates (Shailubai et al., 1984). Additionally, Ryu (1989) reported that pretreatment of waste agricultural residues are with the aim of improving the digestibility of such cellulose waste. Hence, the thrust of this study was to investigate the efficacy of *Aspergillus* treated shea butter cake on feed intake, digestibility and body weight gain of Red Sokoto goats.

MATERIALS AND METHODS

Fungus used

The inoculum (*A. niger*) was isolated from soil sample collected from the cowpea plot of the Teaching and Research Farm, University of Ilorin, Nigeria and maintained on Potato Dextrose Agar (PDA).

Preparation of the substrate and inoculation

Each of the 5 kg of the substrate (Shea-butter cake) containing in polyethylene bag was subjected to autoclaving (moist heat sterilization) for 15 min at 121°C and 15 kgcm^3 in order to kill any likely microbes. After cooling, the substrate was inoculated with the spores of *A. niger*, using heamocytometer (Staples, 1973). About 10^6x10^7 spores were used to inoculate every 1 kg of the autoclaved substrate. The inoculated substrate was then left in an incubation chamber for 7 days to provide all necessary conditions (oxygen, temperature, humidity) for fermentation exercise. At the end of the 7th day, the substrate was dried at 70°C for 24 h (to prevent denaturing of protein) and made ready for use in formulating the experimental diets (Table 1).

Experimental diets

The experimental diets were formulated to contain fungus treated shea-butter cake and untreated shea-butter cake. The control diet (A) had no shea-butter cake, diet B (15% *Aspergillus* treated SBC), C (15% untreated SBC), D (7.5% *Aspergillus* treated SBC) and E (7.5% untreated SBC). Other ingredients are of fixed proportions (Table 1).

Table 2. Performance characteristics of Red Sokoto Goats fed *Aspergillus* treated Shea butter cake based diets.

Parameter	Diet					+SEM
	A	B	C**	D	E**	
Dry matter intake (g/d)	287.70[a]	249.91[ab]	221.99[b]	283.94[a]	270.64[ab]	0.104*
Dry matter digestibility (%)	44.17[a]	51.85[c]	48.66[b]	58.64[d]	49.14[b]	8.75*
Crude protein intake (g/d)	46.95[b]	43.83[ab]	38.55[a]	46.65[b]	42.27[ab]	0.023*
Crude protein digestibility (%)	35.15[a]	58.68[c]	34.47[a]	50.92[b]	52.52[b]	17.80*
Ether extract intake (g/d)	22.79	22.09	20.48	23.48	19.43	0.009 NS
Ether extract digestibility (%)	45.18[a]	44.69[a]	43.35[a]	58.32[b]	44.39[a]	18.76*
Crude fibre intake (g/d)	53.51[b]	31.84[a]	29.64[a]	35.24[a]	36.05[a]	0.016*
Crude fibre digestibility (%)	67.99	64.73	64.29	66.39	62.37	19.75 NS
Acid detergent fibre intake (g/d)	129.29[a]	112.08[b]	89.79[c]	135.01[d]	99.43[e]	0.019*
Acid detergent fibre digestibility (%)	62.02[a]	64.44[b]	65.98[b]	74.54[c]	63.89[a]	10.21*
Neutral detergent fibre intake (g/d)	213.27[a]	150.67[b]	144.07[c]	182.26[d]	192.45[e]	1.85*
Neutral detergent fibre digestibility (%)	50.43[a]	54.29[b]	49.57[a]	59.38[c]	65.48[d]	8.34*
Lignin Intake (g/d)	60.85[a]	48.98[b]	49.28[b]	56.22[c]	54.40[d]	0.20*
Lignin digestibility (%)	93.36[a]	80.34[b]	82.07[b]	87.88[c]	88.37c	10.67*
Hemi cellulose intake (g/d)	101.39[a]	67.90[b]	84.53[c]	108.01[d]	121.62[c]	0.89*
Hemicellulose digestibility (%)	65.35[a]	78.08[b]	68.59[c]	89.12[d]	79.42[b]	10.90*
Cellulose Intake (g/d)	24.66[a]	21.14[b]	21.44[b]	22.66[b]	22.41[b]	0.90*
Cellulose digestibility (%)	65.36[a]	64.04[a]	56.07[b]	57.53[b]	52.06[c]	19.60*
Weight gain (g/d)	30.35[a]	23.21[b]	17.85[c]	28.57[d]	26.78[d]	0.099*
Feed efficiency	0.098	0.089	0.076	0.095	0.094	0.044

Means with same superscribes are not significantly different ($P < 0.05$) from each other.
**Treated Shea-butter cake.

Animal and management

The Red Sokoto goats (n = 25) used for this study were purchased from Ipata Market, Ilorin and kept at the animal pavilion of the Department of Animal Production, University of Ilorin, Nigeria. The animals were treated against ecto and endo-parasites using Ivomec while L-oxytetracycline was used against cold and pneumonia.

The animals were later randomized against the experimental diets in a completely randomized design model for a 56 day period. The animals were weighed at the start and fortnightly till the end of the experimental periods to calculate the average weight gain. The daily feed intake was obtained by deducting the daily feed supplied from the left over. The digestibility trial was determined immediately after the growth study for a 14 day period. The animals were placed in the metabolic cages while the total faecal output of each animal during the collection period was collected daily in a collection bag, weighed accurately and mixed well. A 5% of the daily total faecal output was taken as sub-sample in a labeled polyethylene bags and kept in the freezer (-18°C) until needed to make a composite sample for the entire collection period.

Chemical analysis

The proximate composition of the diets and the faeces were determined using AOAC (1990) method.

Statistical analysis

All data collected were subjected to analysis of variance (ANOVA) of a completely randomized design model (Steel and Torrie, 1960) while treatment means were separated using Duncan (1955) multiple range test.

RESULTS AND DISCUSSION

The chemical composition of the experimental diet is shown in Table 1. The highest crude protein content was recorded for diet B followed closely by diets C, A, D and E in that order. The highest crude protein content of diet B could be due probably to the addition of microbial protein during the process of biological fermentation. The least crude fibre content was recorded for diet D due probably to the action of some enzymes (cellulase, fungal αamylase, pectinase) secreted by the fungus (*Aspergillus niger*) on the substrate (Bolaski and Galantin, 1976).

No digestive disturbance or significant feed rejection was noticed in the animal fed the fungus treated or untreated diets.

Daily dry matter intake was highest in the *Aspergillus* treated diets (B and D) compared to diets C and E of similar levels of Shea butter cake inclusion Table 2. It was also observed that DMI of diet D (7.5% fungus treated SBC) was similar to that of the control diet A (Soybean meal based diet), suggesting that addition of 7.5% *Aspergillus* treated SBC to the diet of goat did not reduce palatability. Also, the increasing intake of *Aspergillus* treated diets could be due to the tannin degrading ability of *A. niger*. This assertion confirms the report of Bhat et al. (1996). Reduction of DMI recorded for diet C indicated low palatability associated with anti-nutritional factors present in SBC.

The average crude protein intake was 50.00, 47.11, 40.69, 49.06 and 44.41 g/d for diets A, B, C, D and E. These averages compared with the values reported by Belewu and Adenuga (2003) who fed similar fungus (*A. niger*) treated diets to goats. It is noteworthy that the average crude protein intake recorded for the fungus treated SBC (7.5 and 15%) was higher compared to the untreated SBC of similar (7.5 and 15%) percentages. However, the fungus treated diet D had similar crude protein intake with that of the control diet (A). This could be due to the addition of fungus protein during the fermentation process. The ether extract intake followed similar trend as the DMI and CPI. Contrarily, the crude fibre intake of diets D and E are similar but significantly higher than diets B and C.

The dry matter digestibility of the fungus treated diets B and D was higher than the untreated diets C and E and the control diet A. The crude protein digestibility followed similar trend as the DMD. The results reported herein supported the results of Belewu et al. (2006).

The higher DMD and CPD might be due probably to the degradation of the Shea butter cake as well as the detoxification of the cake by the fungus before inclusion in the experimental diet. This assertion supported the report of Bhat et al. (1996) that used *A. niger* in the degradation of orcinol. It also agreed with the work of Jacqueline and Visser (1996) that reported degradation or structurally modified protein in such a way that they loose their anti-nutritional qualities.

The ether extract digestibility was significantly highest in diet D compared to other diets which are similar ($P > 0.05$).

Improved weight gain in goats fed *Aspergillus* treated Shea butter cake compared with those fed untreated Shea butter cake was probably related to enhanced microbial activity and (or) to increasing amount of protein reaching the small intestine. Belewu et al. (2003) reported increasing weight gain when fungus treated waste agricultural residues (saw dust, Sorghum stover, and rice husk) were fed to goats. These authors suggested that microbial protein synthesis seemed available to the animal at the lower gut hence, feeding of Red Sokoto goats with *Aspergillus* treated Shea butter cake compared with untreated Shea butter cake improved the nutritional status of goat. Improved nutritional status was probably related to enhanced microbial activity and (or) to increased protein content reaching the small intestine.

Conclusion and implication

Nutritional status of Red Sokoto goats fed untreated Shea butter cake was enhanced by the inclusion of *Aspergillus* treated Shea butter cake in the total mixed ration. Improved nutritional status was presumably related to more desirable ruminal environment for microbial growth and more microbial protein reaching the small intestine. In conclusion, Aspergillus treated shea-butter cake used in this study was more nearly a protein supplement (between 16 and 22% CP) than energy feedstuff hence, higher percent of the product (15% fungus treated SBC) seems promising as a feasible means of converting such waste agricultural residue into viable feed for Red Sokoto goat.

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