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Conversion of Sorghum stover into feed by *Trichoderma harzanium* and the feeding of resulting materials to Red Sokoto goats

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ABSTRACT: *Trichoderma harzanium rifai* was grown in solid-state culture on Sorghum stover and the effects of lignin degradability, nutrient availability, feed intake, digestibility and growth rate were studied using 16 Red Sokoto goats in a 4 x 4 latin square design with a 20 week period consumed diets, A (0% Sorghum stover), B (30% Untreated Sorghum stover), C (30% treated but unwashed Sorghum stover), D (30% treated but washed Sorghum stover). Total DM intake ranked as follows ($P > 0.05$): A (745g) > D (699.35g) > C (670g) > B (580g). Crude protein intake was greatest ($P < 0.05$) for D, greater ($P < 0.05$) for A and C than B. Total ADF and NDF intake rose ($P < 0.05$) for diet D than other diets.

Digestibilities of DM, ADF, NDF, cellulose and lignin were increased ($P < 0.05$) for diet D than for the means of diets A, B and C. Live weight gain was greatest ($P < 0.05$) for diet D, greater ($P < 0.05$) for C than for A and B. In conclusion, feeding of treated but unwashed Sorghum stover to growing Red Sokoto goats improved feed intake, growth rate and digestibility of dry matter and most of the fibrous fractions. Nutritive value of treated but washed Sorghum stover as a major component of diet for growing goats appeared promising than that of untreated Sorghum stover.

Key Words: Fungi; Sorghum stover; Degradability; Nutrient availability; Feed intake; Digestibility.

Introduction

It is evident that Sorghum stover represents the major quantity of biomass formed in cereal production in the Middle Belt of Nigeria. The use of Stover in livestock feeding is limited due to its low nutritional value and low nitrogen content (NRC, 1978). Numerous workers (Adebowale, 1985; Castro et al., 1992) have reported various chemical and physical treatments as a way of improving the digestibility of various lignocellulosic materials.

Biological methods of treating lignocellulosic materials using microbes such as white rot fungi and *Trichoderma harzanium* have also been reported by Belewu and Okhawere, 1998). The solid state fermentation of wheat straw with white rot fungi is a complex process which is being influenced by factors like species of fungi, substrate, moisture, oxygen, nitrogen content and temperature (Kemra and Zadrazil, 1986).

Work on the biological treatment of lignocellulocic agricultural wastes in Nigeria have been reported (Belewu, 1998; Belewu and Okhawere, 1998; Belewu and Banjo, 1999). The objective of this study was to evaluate the effects of treating Sorghum stover with *Trichoderma harzanium rifai* on the degradation, nutrient availability, feed intake, digestibility and growth rate of Red Sokoto goat and to compare the parameter of fermentation with untreated Sorghum stover.

Materials and Methods

The substrates (control, untreated Sorghum stover, Sorghum stover treated with the fungi *Trichoderma harzanium rifai*) were used for the experiment. For solid state fermentation with Basidiomycetes, samples of moistened Sorghum stover (water content, 80%) were placed into separate containers for sterilization. After sterilization, the stover was inoculated with homogenised mycelium of *Trichoderma harzanium* grown for 8 days under static condition on potato dextrose agar (PDA). All treatments were carried out at ambient temperature for a period of 40 days.

The growth of the fungi was terminated on the 40th day by oven drying at 70^{o}C for 48 hours. The treated Sorghum stover was used in the formulation of the diets. Diet A (control) contained cassava wastes as the carbohydrate source while Sorghum dried brewer's grain and soyabean were the protein sources. Diet B contained untreated Sorghum stover while diet C contained treated but unwashed Sorghum stover and diet D had treated but washed Sorghum stover. The purpose of washing is to get rid of any vegetative part of the fungi which could have influenced the proximate composition of the substrate.

Animals and Management

Sixteen Red Sokoto goats (7.7 ± 0.5 kg mean initial body wt.) were divided into four groups and randomised against the experimental diets in 4 x 4 Latin square desing model. The goats were treated against ectoparasites and endoparasites before the commencement of the experiment. Each goat was given the experimental diets *ad libitum* while the amount fed and wayback was recorded daily. The animals were weighed at the beginning of the trial and every other week throughout the experimental period.

Measurements

The chemical composition and fibre fractions of the diets and stover were determined onn the 1st and 40th day after inoculation by the method of A.O.A.C. (1985) and Van Soest (1963) respectively while the feeding and growth trial lasted 20 weeks. There was an adjustment period of 7 days after which measurements were made for the next 8 to 140 days. The nutrient availability, feed intake, digestibility and growth rate were monitored.

Statistical Analysis

All data collected were subjected to analysis of variance (ANOVA) using the model of a 4 x 4 Latin square design while treatment means were separated by Duncan's multiple range test (Duncan, 1955).

Nutrient Availability

The nutrient availability from the treated Sorghum stover was calculated by the method of Kamra et al. (1992) as follows:

$$Nt = \frac{(100 - DML)\ Dt}{100}$$

where,

Dt = Dry matter digestibility of treated stover.

Nt = Nutrient availability from treated stover.

DML = Dry matter loss (%) during fungal growth.

$$\% \text{ Lignin loss} = \frac{\text{Loss of lignin during treatment}}{\text{Weight of sample before drying}} \times 100$$

Results and Discussion

The loss of lignin increased from 18.80% on the 10th day to 39.76% on the 40th day due to the long incubation period when the soluble carbohydrate could have been used while the lignin is preferentially attacked by the fungi (Table 1).

Table 1: Degradation characteristics of *Trichoderma* treated Sorghum stover.

Duration (Days)	% Loss of organic matter	% Loss of lignin	Process efficiency LOL:LOM
0	–	–	
10	30.76	18.80	0.61
20	23.50	25.38	1.08
30	15.80	29.72	1.88
40	10.20	39.76	3.90

The process efficiency (LOL: LOM) was very low on the 10th day of incubation while the highest process efficiency (3.90) for loss of lignin was on the 40th day.

The loss of organic matter was lowest (10.20%) on the 40th day compared with other days. The highest loss of organic matter (30.76%) and lignin (39.76%) was reported on the 10th and 40th days respectively, and this agrees with the report of Belewu (1998).

The maximum increase in nutrient availability (50.78%) and DMD (48.08%) was observed in the treated sample which degraded only 39.76% of lignin present initially in the substrate. This might be responsible for the differences in the dry matter intake of the untreated and treated stover 580.00 vs 684.68 g/d.

These results are similar to the report of Belewu and Okhawere (1998) who observed that the fungus (*Trichoderma harzanium*) is a good lignin degrader.

Feed intake, digestibility coefficient and growth rate

Dry matter intake was similar in diets A (control) and D ($P > 0.05$) but was significantly higher in diet B (untreated Sorghum stover). The crude protein consumption was highest in diet D (containing treated but washed Sorghum stover) while the fibre fractions (ADF, NDF, cellulose and holocellulose) consumption were significantly reduced in diets A and B. The higher digestibility of the fibre fractions recorded for diets C and D could be explained by the pre-digestion of fibre fractions by the fungi. The balance of metabolic energy achieved the highest values in the diet containing washed treated Sorghum stover while it was significantly lower in diet B but the differences are similar between diets A and D.

Table 2: Composition of the experimental diets (%)

Ingredients	Concentrate diets			
	A	B	C	D
Cassava waste	50.00	20.00	20.00	20.00
Sorghum stover	–	30.00[b]	30.00[c]	30.00[d]
Palm kernel cake	15.00	15.00	15.00	15.00
SDEC[a]	33.00	33.00	33.00	33.00
Vitamin-mineral premix.	1.00	1.00	1.00	1.00
Bone meal	0.50	0.50	0.50	0.50
Common salt	0.50	0.50	0.50	0.50
Proximate and dtergent fibre composition (%)				
Dry matter	90.00	96.00	88.00	92.00
Crude protein	19.50	18.90	21.43	23.62
Acid detergent fibre (ADF)	31.26	39.36	38.54	38.50
Neutral detergent fibre (NDF)	45.77	62.69	52.96	51.90
Cellulose	24.30	35.30	29.17	29.10
Lignin	6.51	8.08	6.24	6.22
Holocellulose	44.07	58.24	49.12	49.05
ADF:NDF	0.68	0.63	0.73	0.74
Cellulose:Hemicellulose	1.23	1.54	1.46	1.53
Gross energy[e]	4.02	4.30	3.97	4.21
Hemicellulose	19.77	22.94	19.95	19.00

[a]Sorghum dried brewer's grain.

[b]Untreated Sorghum stover

[c]Treated Sorghum stover but unwashed

[d]Treated Sorghum stover but washed

[e]Calculated from the proximate composition.

The fibre digestibility coefficient was different among the diets. The most intensive digestibility was realised in diet D (Table 3) evident from the highest dry matter, crude protein and energy recorded for this diet. Only the intake and digestibility of ADF, NDF and cellulose were similar in diets A and B.

Table 3: Mean liveweight gain, feed intake and digestibility of Red Sokoto goats fed fungi treated based concentrate diets.

Parameters	Concentrate diets				SEM
	A	B	C	D	
Weight gain (g/d)	50.00	48.00	60.00	65.80	10.45
Drymatter intake (g/d)	745.00[a]	580.00[c]	670.00[b]	699.35[ab]	10.45*
Digestibility (%)	41.54[a]	36.45[bc]	33.50[c]	48.08[c]	4.81*
Crude protein intake (g/d)	146.10[a]	110.10[b]	145.23[a]	165.75[c]	7.30*
Digestibility (%)	62.00[a]	54.11[a]	47.30[b]	56.30[a]	4.59*
ADF intake (g/d)	232.89[a]	228.29[a]	258.22[b]	269.25[b]	8.30*
Digestibility (%)	45.32[a]	36.15[a]	58.12[b]	60.25[b]	3.28*
NDF intake (g/d)	340.99[a]	350.60[a]	354.83[a]	362.96[b]	9.15*
Digestibility (%)	48.10[a]	35.75[a]	60.32[b]	62.19[b]	4.50*
Cellulose intake (g/d)	181.04[a]	190.74[a]	195.44[a]	203.51[b]	7.50*
Digestibility (%)	36.18[a]	35.10[a]	46.44[b]	55.04[b]	4.70*
Holocellulose intake (g/d)	328.32	337.79	339.10	343.03	9.35NS
Digestibility (%)	38.96[a]	40.7[a]	48.64[b]	56.98[c]	3.75*
Lignin intake (g/d)	48.50	46.86	41.81	43.50	4.34
Digestibility (%)	32.53[a]	35.83[a]	47.12[b]	50.23[b]	3.50*
Digestible protein (g)	15.19	14.46	16.88	18.89	1.50NS
Metabolizable energy (Mcal)	1.49	1.18	1.35	1.40	0.90
Digestible energy (Mcal)	1.81	1.44	1.68	1.79	0.95
Feed:Gain ratio	14.9	12.88	11.17	10.62	2.65

Means followed by different superscripts are significantly different ($P < 0.05$)

NS = Not significant ($P > 0.05$)

1Kg DM = 2.0 Mcal (ME) (NRC, 1987); DE = ME/0.82.

There was also a loss of 39.76% lignin for an increase in DMD of treated Stover. This is in agreement with the reports of Kamra and Zadrazil (1986) and of Kamra et al. (1993). When digestible crude protein and energy intake were calculated, the digestible protein was lowest in diet B and highest in diet D. The digestible CP and energy were significantly higher in diet D. The DP content of diets (A - D) was adequate for animals of this age (NRC, 1987). However, diet D had the highest DP, DE and ME which actually satisfied the amount recommended by NRC (1987) for maintenance and growth of animals of similar weight.

The weight gain of animals on diet D was greatest ($P < 0.05$), greater for C and A and great for B. The best feed efficiency was recorded for animals on diet D compared with other diets.

The results of this study confirm the reports of Mudgel (1986) that treatment of fibrous materials with microbes encouraged the pre-digestion of the fibrous wastes thereby enhancing the digestibility of the rumen microbes which then attack the crude fibre more vigorously.

Conclusion

The treatment of lignocellulosic materials with fungi is characterized as the preferential degrdation of the fibrous matrix leaving a substrate enriched with crude protein and lower crude fibre. the biological treatment of Sorghum stover with fungi (*Trichoderma harzanium rifai*) was effective in converting such waste into useful animal feed and the parameter of fermentation and nutrition of the treated diets were comparable with the control diet and better than the untreated Sorghum stover (Diet B). To date, treatment of agricultural waste with microbes are not well documented in Nigeria. In succeeding experiments in this area, the influence of such diets on milk yield and composition will be reported.

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