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Effect of treating rice husk with *Aspergillus niger* on the feed intake and digestibility of West African dwarf goat (*Capci hircus*)

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Abstract

Effect of feed intake and digestibility of fungus-treated rice husks on growing goats was determined. Sixteen West African dwarf goats (Av. Initial body weight = 4.85kg) in a completely randomized design model with 56 days period consumed untreated rice husk control diet A (30%) inclusion level of non fungal treated rice husk) and fungal treated rice husk diets B (10%), C (20%) and D (30%). Total crude protein intake increased (P<0.05) with fungal treatment of rice husk and was similar among treated diets 18.9g/d (A), 21.7g/d (B), 24.6g/d (C) and 23.6g/d (D). On the contrary, the crude fibre intake decreased significantly (P<0.05) for the fungal treated diets than the control (diet A). Total dry matter digestibility in the last week of the trial ranked (P<0.05), B(76.6%) >D(75.4%) >C(74.6%) and >A (69.7%). Crude protein and crude fibre digestibilities increased (P<0.05) for the treated diets than for diet A (control). Live weight gain was greater (P<0.05) for diet C, greater (P<0.05) for D than A (control). Dry matter intake: weight gain was greater (P<0.05) with than without fungal treatment. Inclusion of Aspergillus niger treated rice husk in growing goat diet result in high digestibility of organic matter and better weight gain by the animals.

Keywords: *Aspergilus niger, rice husk, feed intake, digestibility.*

Introduction

The West African dwarf goat, which is trypanotolerant and predominantly the breed of goat found in the southern and middle belt of Nigeria contributes largely to the economic and nutritional values of the people. There are constraints in the feeding of the animal mostly during the dry season when the forages are dried while most of the waste agricultural residues, which abound on the farm constitute nuisance to the environment.

There is limitation to the consumption of these residues by livestock due to high fibre content.

According to nutrient requirement [1], the recognition of the importance of dietary fibre and protein in ruminant nutrition has re-opened a new method of processing waste agricultural residues. Consequently, a considerable body of literature has been documented on the utilization of fibrous feedstuffs by goats [2,3]. The selective utilization of the fibrous materials is limited due to the complexity of the three polymers, cellulose, hemicellulose and lignin contained in these raw feedstuffs.

Given the complexing of lignocellulose and indeed lignin, rice husk which represents 20% of the unmilled rice with annual world production of about 59 million tons (MT) is likely constituting a nuisance to the

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environment [4]. The husk is poor nutritionally and usually indigestible in ruminant gastrointestinal tract (GIT) [5]. However, investigation into the processing of waste agricultural residue is of particular importance in the tropics where many indigenous feedstuffs and by-products are fibrous [6]. Various physical, mechanical and chemical processing methods are well documented [7, 8,9].

The biological methods of processing these wastes are still at infancy stage in Nigeria. Various microorganisms have been used on some agricultural wastes with encouraging results [10,11,12,13]. The microorganism when incubated on the substrate degrades and solubilize these complex polymers. The solubilization and degradation require that a number of enzymes act synergistically on the substrate. However, the enzymes secreted by *A. niger* [14, 15] include cellulose, xylanases, pectnases, amylase, manganese and more recently peroxidases. Apart from the degrading ability of *A. niger*, the fungus was used to dexotify tannins [16, 17] compounds which have wide ranging effect on animals and microbes [18, 19]. The fungus was also reported to be capable of degrading a variety of aromatic compounds (Salicylate resorcinol) [20]. The degradation and detoxfying ability of *A. niger* stimulated this study. Hence, the thrust of this study was to evaluate the feed intake, feed efficiency and digestibility coefficient when growing goats are fed *A. niger* treated rice husk based diet.

Materials and Methods

Aspergillus niger was isolated from soil samples collected from cowpea plot of the Teaching and Research Farm, University of Ilorin, Nigeria, through the following procedure, soil sample were randomly collected at 5 different spots on the cowpea plot and later bulked together. A 10g sample of the soil was weighed into 90ml sterile distilled water.

From the suspension, 1ml was pipetted into 9ml sterile distilled water contained in the first test tube, while 1ml of the content from the first test tube was pipetted into second test tube containing 9ml sterile water and a new pipette was used to pipette 1ml of the content in the second test-tube into the third test tube (serialy dilution method). Later, 1ml of the serially, diluted sample pipetted into each sterile petri dishes containing molten Potato Dextrose Agar (PDA) at 45^{0}C were incubated at room temperature for 24 – 72 hrs. The wet smear of the colonies that emerged were prepared and stained with lactophenol stain. The slides were later observed under the microscope for further characterization according to the method of Robert and Reenen-Hoekstra [21]. Rice husk was obtained from the rice-milling centre Kulende, Ilorin, Nigeria. It was sterilized in an autoclave at 121^{0}C, 15psi and for 15 minutes. The content was allowed to cool before inoculation with *A. niger*.

Inoculation and Incubation procedure

The spores of *Aspergillus niger* were harvested with Tween 80 solution and adjusted to $10^7 - 10^8$ spores per ml with sterile water (serial dilution and haemocytometer methods). Each bag (25g) of the sterilized substrate was inoculated with 5ml of the spore suspension containing 10^7 spores per ml. The inoculated substrates were later incubated at ambient temperature, and within 7 days the fungus covered the substrate. The fungus treated rice husk was later oven dried in a forced draught laboratory oven at 60^{0}C in readiness for inclusion in the experimental diet (Table 1).

Animal and Management

Sixteen West African dwarf (WAD) goats were bought from the local market and treated against ecto and endo-parasites. The goats, which weighed between 4.3 and 5.4kg were randomly allocated to four groups with different age groups represented in each group. One group consisted of four animals, which served as the control while the other three groups each consisting of four animals was randomly allocated to three different groups B, C and D respectively.

Experimental diets

The experimental animals were randomized against the treatments consisting of four diets. Diet, A which was the control, contained untreated rice husk with 30% inclusion level. Diets B, C and D contained 10, 20 and 30% of fungus treated rice husk substituted for cassava waste respectively. Other ingredients (Table 1) were of fixed amount in all the experimental diets. Feed and water were provided *ad libitum* to each experimental animal for 56 days.

Measurements

The following parameters were monitored thus: feed intake, weight gain and digestibility coefficients. The experimental animals were fed *ad libitum* per day while the left over (orts) for each day was collected, weighed and subtracted from the amount given each day to know the feed consumed daily. The weight gain of he experimental animals was determined by standard procedure.

The digestibility trials were carried out during the last 14 days of the study when the animals have adjusted to the experimental diets. The animals were kept in the metabolic cages, which have facilities for separate collection of the faeces and urine. A total collection method was employed while digestibility coefficient was determined by difference [22].

Chemical analysis

The samples (feed, faeces and orts) were analysed in triplicate for the proximate composition (crude protein, crude fibre, ether extract, nitrogen free extract, acid detergent fibre, lignin) using the method of A. O. A. C. [23].

Statistical analysis

The results obtained were analysed using the Analysis of Variance of a Completely Randomised Design Model [24] and the means separated by Duncan Multiple Range test [25].

Results and Discussion

Composition of the experimental diets

The formulation and proximate composition of the experimental diets fed to the WAD goats during the feeding and digestibility trials are presented in Tables 1 and 2. The treatment of the rice husk with *A. niger* resulted in numerical increase in crude protein and nitrogen free extract (NFE) while the crude fibre, ADF and lignin decreased. Similar increases in crude protein and NFE with decrease in the crude fibre and fibre fractions were reported for *Aspergillus* treated cassava waste [26] and treated rice husk (27). In general, the fungus treated rice husk was relatively higher in crude protein and NFE than *Panicum maximum* hay [28].

Feed intake

No sign of impaired health was observed in all the experimental animals during the course of the study. The dry matter intakes per day were 199g, 233g, 235g and 197g for diets A, B, C and D respectively. Diets B, and C tend to be consumed in greater amount than diets A and C, but the difference was not significant ($P>0.05$). The crude protein intake of the animals was greater for the fungus treated rice husk based diets (B, C and D) than the untreated diet A. This is probably due to the addition of fungal protein [29] to the diet during inoculation and incubation of the husk with *A. niger*. The release of these poly-saccharide bound protein increased the nutritive value of the diet [2]. The inclusion of fungus treated rice husk in the diet also caused reduction in the fibre fractions and crude fibre intake by about 46%. The weight of animals fed on the treated husk increased more than twice compared with those fed on the control diet (A).

The effects of fungus treated rice husk based diet on digestibility coefficients of organic matter are shown in Table 3. Inclusion of fungus-treated rice husk in the diet caused a significant increase ($P<0.05$) in the digestibilities of protein, NFE, crude fibre and other fibre fractions (ADF, lignin) whereas, the digestibility of ether extract did not follow any particular trend. Despite the low intake of fibre and fibre fractions, the digestibility improved significantly ($P<0.05$). This might be due to the product of microbial metabolism, which provides the animals with assimilable energy materials and protein rich microbial cells [30].

Conclusion

On the basis of the feeding studies, it appears that biological treatment and inclusion (20%) of *A niger* treated rice husk in the diet of West African dwarf goats may be a feasible means of converting agricultural wastes into a palatable and nutritious feed for ruminants. In addition to improving the nutrient content of rice husk, the method would assist in cleaning the environment of such waste as well as enhancing feed supplies and increase meat and milk production in Nigeria.

Table 1: Formulation of the experimental diets (%)

Ingredients %	DIETS			
	Untreated		Treated	
	A	B	C	D
Cassava waste	32.0	52.0	42.0	32.0
Rice husk	30.0[a]	10.0[b]	20.0[b]	30.0[b]
Sorghum dried brewer grain	26.0	26.0	26.0	26.0
Palm kernel cake	10.0	10.0	10.0	10.0
Salt	1	1	1	1
Vitamin-mineral premix	1	1	1	1
Total (kg)	100.00	100.00	100.00	100.00

a = Untreated rice husk b = Aspergillus treated rice husk

Table 2: Proximate Composition* (%) of the Experimental Diets

Parameters	DIETS				
	A	B	C	D	±SEM
Dry matter	94.95	93.00	94.00	94.02	6.89NS
Crude Protein	9.50	10.75	12.45	15.93	2.01*
Crude Fibre	28.35	13.65	11.10	10.15	3.28*
Ether extract	7.00	4.10	4.75	6.10	1.25*
NFE	42.80	62.26	61.60	60.37	4.72*
ADF	74.0	54.50	37.50	52.30	5.31*
Lignin	86.38	52.76	54.80	50.61	-5.72*

** Means of 4 determinations.*

Table 3: **Feed Intake Weight gain and digestibility coefficient on the experimental diets by West African dwarf goats.**

Parameters	DIETS				
	Untreated	Treated			
	A	B	C	D	±SEM
Dry matter intake (g)	199.40	223.20	235.00	197.00	18.50[NS]
Dry matter digestibility (%)	67.20	76.57	74.56	75.38	11.35
Crude protein intake (g)	18.94[a]	21.74[b]	24.56[c]	23.58[c]	4.32*
Crude protein digestibility (%)	67.20[a]	72.13[b]	74.27[c]	72.20[b]	11.42*
Crude fibre intake (g)	56.53[a]	30.47[b]	26.09[c]	20.04[d]	10.75*
Crude fibre digestibility (%)	72.12[a]	79.00[b]	90.91[c]	91.70[c]	12.13*
Ether extract intake (g)	13.96[a]	9.15[b]	11.16[c]	12.04[c]	3.17*
Ether extract digestibility (%)	83.95	70.81	74.60	80.07	13.95
Nitrogen free extract intake (g)	85.34[a]	134.50[b]	144.76[c]	119.17[d]	16.23*
Nitrogen free extract	64.61[a]	71.78[b]	78.16[c]	70.47[b]	11.50*
ADF intake (g)	187.44[a]	121.64[b]	88.13[c]	103.24[d]	18.23*
ADF digestibility (%)	60.47[a]	74.76[b]	73.07[c]	75.47[b]	11.12*
Lignin intake (g)	172.24[a]	184.72[b]	152.28[c]	150.64[c]	17.25*
Lignin digestibility (%)	69.98[a]	84.28[b]	66.42[c]	77.96[c]	11.75*
Dry matter intake/gain	25.05	14.22	11.44	11.64	3.95
Weight gain (g)	7.96[a]	15.70[b]	20.54[c]	16.96[b]	2.10*

Mean followed by different superscripts are significantly different (P<0.05)
NS = Not significantly different (P>0.05)

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