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Research Article

Invitro Fermentation Performance of West African dwarf (WAD) Goat Fed Rice Husk Treated as Substitute for Wheat Bran

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Abstract

The research was conducted to evaluate the in-vitro fermentation characteristics of West African Dwarf goat fed rice husk treated as substitute for wheat bran. A 20 growing West Africa Dwarf goats were divided to five dietary treatments in a completely randomized design with 4 animals per replicate while the treatments are: 0% RH (T1), 25% RH (T2), 50% RH (T3), 75% RH (T4) and 100% RH (T5). The animals were fed at a rate of 5% of their body weight. The results showed that T2 and T1 were relatively high in crude protein, low in crude fiber, moderate in crude fat and high in carbohydrate level. Lowest values of ADF, ADL and NDF were observed among the treatments. The gas volume produced under each treatment continues to increase at every three hours. The production of gas was significantly ($P<0.05$) influenced by the incubation period and that T1 produced more gas while T5 had the least gas production. The methane gas was least in goats fed treatment 4, while diet T5 produced the highest and same methane gas quantities. In conclusion, treated rice husk as a substitute for wheat bran at 25 and 75% inclusion level gave better in-vitro fermentation performance in the WAD goat.

Keywords: *Treated rice husk, WAD goat, weigh gain, feed conversion ratio, feed intake*

Introduction

Ruminants are physiologically adapted to obtain nutrients from grass and convert this low-quality, high-fiber feed into milk and meat, which are important sources of protein, fat, minerals and vitamins (Alasa, 2014). Goats are ruminants that play a very important role in livestock production in Nigeria (Agossou *et al.*, 2017). Goats play an important socioeconomic role in populations in many parts of West Africa. African goats make up 30% of the African ruminant population and provide approximately 17% and 12% of meat and milk, respectively (Agossou *et al.*, 2017). Green fodder is abundant during the rainy season while during the dry season, grasses for livestock will become a problem. Thus, inadequate feeds during the dry season is a serious problem in many areas where grazing is the main form of feeding for ruminant livestock. The death of fresh forages in the dry season in Nigeria and the consequent loss of body weight by ruminants necessitate the need to search for alternative feeds that are less competitive for their use by man and other livestock animal (Adewumi and Ajayi, 2010).

Thus, the use of low quality waste by-product like rice husk as an animal feed could perhaps be one of the intervention areas needed to augment small ruminants' production in dry season (Ikpe *et al.*, 2019; Omotoso and Arilekolasi 2019). Rice husks constitute a by-product of rice production.

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Rice husk can be incorporated in small amounts (15%) in highly concentrated ruminant feeds to increase bulk, stimulate appetite and reduce the incidence of liver abscesses (Marte *et al*., 2021). A problem with rice hull is that it is difficult to break down due to its high silica content, fiber and abrasive nature, limiting its use as an animal feed ingredient (Ikpe *et al.*, 2019). Although ruminant is blessed with ruminal degradation due to microorganisms present in the rumen of ruminants, rice husk may stay longer in the rumen because of its poor quality (high lignin content). However, improved utilization of crop residues such as rice husk can be achieved either through appropriate supplementation or application of treatment methods such as alkaline hydrolyses, ensiling, fermentation, use of enzymes etc. which facilitate the microbial breakdown of plant cell wall and ensure efficient utilization of the husk (Kolo *et al.,* 2017).

Manipulation of rumen microbial ecosystem for enhancing fibrous feed digestibility, reducing methane emission and nitrogen excretion by ruminants to improve their performance is some of the most important goals as animal nutritionists. Hence in vitro fermentation is a very useful method for the quick evaluation of feedstuffs to assess their potential as energy sources and to predict organic matter digestibility and metabolizable energy content of ruminant feeds with high accuracy. The in vitro gas production technique has remained a better alternative for the determination of gas production kinetics and energy value of ruminant (Isah *et al.,* 2012). The in-vitro fermentation technique has been affirmed as a useful evaluation tool for the determination of chemical composition, the relationship between incubation time and digestibility of forage and acceptability evaluation of some plant species in southern guinea savannah zone of Nigeria (Ogunbosoye, 2016). It is evidence as indicated above that many findings have been conducted on *in vitro,* however, there is paucity of information on the in vitro fermentation performance of WAD goat fed treated rice husk as replacement of wheat bran. Therefore, the study is aimed evaluating the in vitro fermentation characteristics of rice husk fed as substitute of wheat bran to West African dwarf goat.

In order to overcome these problems of feed shortage and low productivity of West African Dwarf goats in the tropics, rice husk which is locally abundantly available, cheap, non-competitive with other livestock and humans can ameliorate the problem. It is a product that can be used as an alternative feed to improve the productivity of ruminants. However, processing through cooking and fermentation can improve nutrient content, which could be a way to reduce year-round production costs and increase feed availability in ruminant aquaculture. The overall goal was to**:** Evaluation of the performance value of replacing wheat bran with processed rice husk fed to WAD Goat. The specific goal was to**:** Determine the chemical composition, acceptability and *in vitro* fermentation of processed rice husk that can substitute for wheat bran in formulations.

Materials and Methods

This research work was conducted in the small-scale ruminant department of the Research Farm, Faculty of Agriculture, Kwara State University, Nigeria. 500 g of rice husk purchased from rice processors in the study area was weighed into a pot with 3 liters of boiling water. The mixture was boiled for 150 minutes with continuous stirring until a homogeneous mixture was obtained. The cooked rice husk was filtered to remove excess water and dried to 35% dry matter. After which the rice husk was packed inside an air-tight polythene bag and it was allowed to ferment for 20 days after which it was dried, packed and weighed to formulate experimental diets (Table 1).

Twenty (20) WAD goats of an average weight of 8.6 kg used in this study were randomly allocated into five treatments with four replicate animals per treatment; (T10% rice husk), (T2, 25% rice husk), (T3, 50% rice husk), (T4, 75% rice husk) and (T5, 100% rice husk) to replace wheat bran in their diet in a completely randomized design. The feeding trial covered a period of 84 days during which the experimental diets were served at 5% body weight and clean water was provided ad libitum.

Chemical composition of the experimental diet: Dried samples were analyzed for crude protein, crude fibre, ether extract, and ash, according to the methods described by AOAC, (2012). 200 g were taken from each of the treatment sample and oven-dried to a constant weight at 65^0C. The dried samples were grounded and sieved with a mesh size of 1 mm and the crude protein was determined using a Kjeldahl microdistillation apparatus. Neutral detergent fibers, acid detergent fibers, and acid detergent lignin were determined according to the method of Van Soest (1995). Hemicellulose was calculated as the difference between NDF and ADF, and cellulose was calculated as the difference between ADF and ADL.

Invitro Fermentation of feed samples: In-vitro fermentation was determined according to Menke and Steingass (1988). Rumen fluid was collected from 3 goats using a suction stomach tube before morning feeding (Babayemi and Bamikole, 2006). The rumen liquor was collected into a pre-warmed thermos flask and was later filtered through three layers of cheese cloth. Ground feed samples of 200 mg were weighed into 50 ml calibrated syringes with pistons lubricated with grease. A buffered mineral solution was prepared. 30 ml of buffered rumen fluid was taken into syringes containing feeds. Each sample was measured in triplicates and the syringes were tightly capped. The syringes were positioned vertically in a water bath with shaker kept at 39^0C fitted with plungers with 3 blank syringes 30ml of medium inoculum and buffer (9.8 g $NaHCO_3$ + 2.77 g Na_2HPO_4 + 0.57 g KCl + 0.47 g NaCl + 0.12 g $MgSO_4.7H_2O$ + 0.05 g $CaCl_2.2H_2O$ + 1 g urea) only as control under continuous flushing with CO_2. Gas production rates were recorded at 3, 6, 9, 12 and 24 hour of incubation and each syringe was gently swirled after reading. Three blank syringes containing 30ml of buffered inoculum were also concurrently incubated. At post - incubation period, 4 ml of NaOH (10 M) was introduced to estimate methane production as reported by Fievez *et al*. (2005). The average of the volume of gas produced from the blanks was deducted from the volume of gas produced per sample. The volume of the gas produced at intervals was plotted against the incubation time, and from the graph, the gas production characteristics were estimated using the equation Y = a + b (1 – e-ct) described by Ørskov and McDonald (1979), where

Y = volume of gas produced at time‘t’
a = intercept (gas produced from the soluble fraction),
b = gas production from the insoluble fraction,
c = gas production rate constant for the insoluble fraction (b),
t = incubation time.

Statistical Analysis: Data collected for all determined parameters were subjected to Analysis of Variance (ANOVA) and differences between treatment means were separated by least significance difference using General Linear Model procedure of Statistical Analysis System (DSAASTAT, 2011).

Results and Discussion

Proximate compositions: The chemical compositions of the experimental diets used in this study are presented in table 2. All the parameters examined were significantly different ($p < 0.05$) among the treatment groups except the cellulose and hemicellose. The maximum value of crude protein (CP) was found in T2 (13.0%) and minimum in T5 (7.5%) while a greater crude fiber content was recorded in T4 than the others T3, T5, and T1.

All the diets had crude protein (CP) values above the 6 – 8% CP the minimum requirement for ruminants (Faisal *et al.*,2017) in nutrient requirements of domestic Animals. The crude protein levels of the experimental diets were far above the 8% needed to provide the minimum ammonia levels required for microbial activity in the rumen. Faisal *et al.*, (2017) reported that low-cost concentrates with CP greater than 8% could be a good dry-season maintenance diet for ruminants. In the study, the crude fiber content of the experimental diet was lower than the value reported by Oladotun *et al*., (2003) (34.85%). This contrast may be a result of including processed rice hulls in the diet.

The ash content increased as the amount of rice hulls increased, and the same trend was observed in ADP. However, the carbohydrate content recorded a declining trend as the rice husk quantity increases. The crude protein, crude fibre, crude fat, ash and CHO values obtained for the experimental diets used in this study were similar to the values reported by Fasuyi *et al.,* (2010). The values of ADF, NDF and ADL for all the experimental diets were lower than the values 62.29% NDF, 47.83% ADF and 20.25% ADL reported by Oladotun *et al.,* (2003).

According to Robert (2013) ADF is used to produce energy content of feed which goes with the T5 (100%RH) having the highest ADF with higher energy content.

Invitro fermentation characteristics of the samples: The *invitro* fermentation characteristics of replacement value of wheat bran with treated rice husk diets incubated at 24 hours is presented in Table 1. Mean values varied significantly ($P < 0.05$) between treatments. In the case of T-5 (100% RH) after 24 hours, the smallest gas volume of 18.33 ml was recorded, and the highest gas volume was obtained in T1 (0% RH, 31.67 ml) after 24 hours. Gas production increased with increasing incubation time. High gas production on the T1 diet (0% RH) may be due to the low crude fiber content of the diet. The low gas production of the T5 diet (100% RH) indicates that it takes longer to break down in the rumen due to its higher fiber content. Ogunbosoye (2016) noted in a previous study that diets that take longer to break down in the rumen contain higher amounts of lignin. The in vitro gassing model of this study shows that further degradation of the dry matter is still possible after 24 hours. An insoluble but degradable fraction at T1 (0% RH) after 24 h incubation may result from high crude protein processing. The high value of 31.67 ml during fermentation indicates that longer incubation times are likely to result in worse processing (Ogunbosoye, 2016). The significance of this study was consistent with Amuda and Onaleye (2018), who observed similar values. Figure 4.1 shows methane production (mmol) per 24 hours replacing RH-treated wheat bran with WAD chlorine productivity. A significant difference ($P<0.05$) was observed in methane production at 24 hours. The higher methane gas production values (6 mmol) were observed for diets T2 (25% relative humidity), T-3 (50% relative humidity) and T5 (100% relative humidity). The lowest methane gas production values were obtained at T4 (75% RH, 4 mmol).

Therefore, a diet containing 75% processed rice hulls (T4) is superior because it produces the least amount of methane gas. Similar finding was also reported by Babayemi and Bamikole (2009). The high methane production could be as a result of highly fermentable substrate in their diets available for rumen microbes. Methane production has negative impact on animal productivity. It indicates energy loss and a significant wasteful product as the part of feed degraded to methane is eructated as gas (Amuda and Onaleye, 2018). CH4 rises with increasing digestibility of ration, thus increased methane production in T2 (25%RH), T3 (50%RH) and T5 (100%RH) may be due to reduced crude fibre in the diets while the low methane recorded in T1 (0%RH) and T4 (75%RH) may be due to high fibre content. Ogunbosoye *et al.,* (2017) argued that low methane production suggests that the feed ingredient will inhibit methane production.

Conclusion

The results of this study showed that a 25% substitution of wheat bran with processed rice husk (T2) was more nutritious with less coarse and a noticeable carbohydrate content and resulted in a higher intake of goats in the diet. As the incubation period progresses, extracorporeal gas production from each treatment continues to increase every 3 hours. T1 produced more gas than the rest of the treatments. A diet with 75% rice husk replacement produced less methane gas than any treatment. Thus, rice husk treated as a substitute for wheat bran at 25% and 75% inclusion levels provided better in vitro fermentation performance in goats favouring a positive economic implication.

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Table 1: Composition of the experimental diets (%).

	Treatments				
Parameters (%)	T1 (0%RH)	T2 (25%RH)	T3(50%RH)	T4(75%RH)	T5(100%RH)
Rice husk	0	12.5	25	37.5	50
Wheat bran	50	37.5	25	12.5	0
Cassava peel	30	30	30	30	30
SBCW	10	10	10	10	10
PKC	5	5	5	5	5
Bone meal	3	3	2.8	2.6	2.4
Lime stone	1	1	1	1	1
Salt	1	1	1	1	1
Urea	-	-	0.2	0.4	0.6
Total	100	100	100	100	100

T1,0%RH, T2,25%RH, T3,50%RH, T4,75%RH, T5,100%RH, SBCW = Soybean cheese waste, PKC = Palm kernel cake.

Table 2: Chemical composition (%) of the experimental diets.

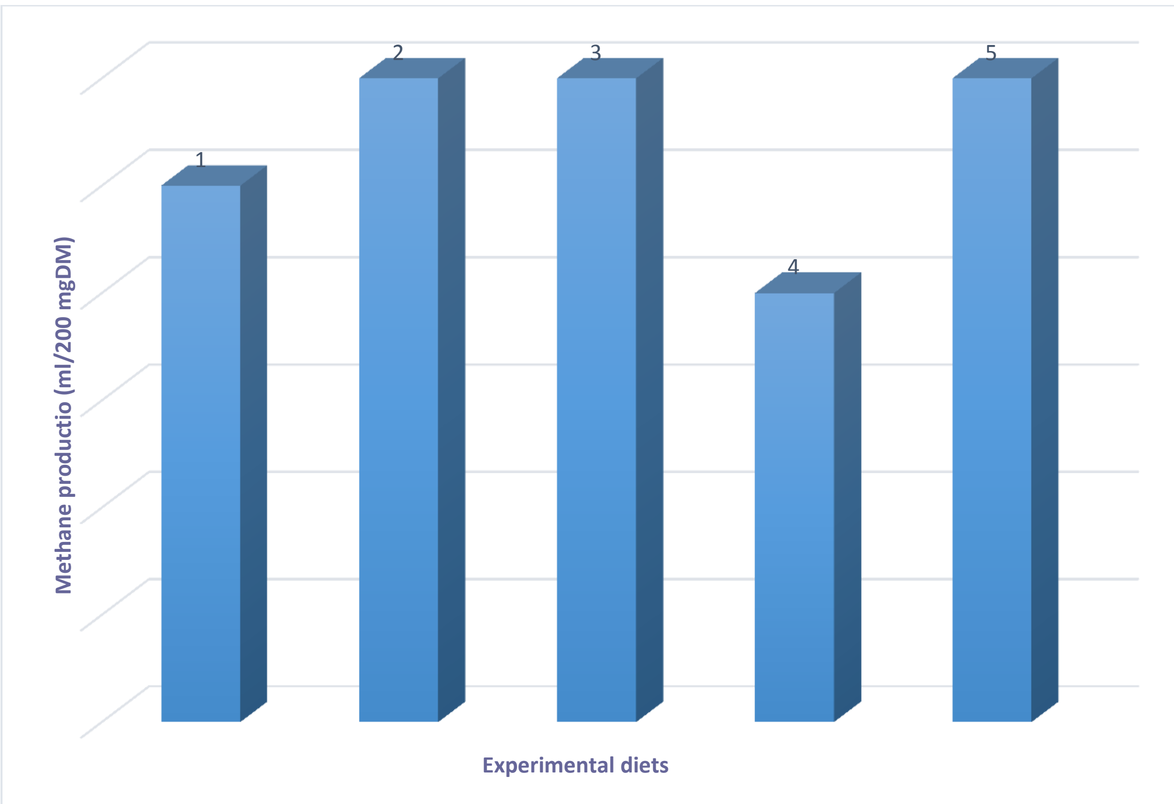
Treatmt	DM	CP	CFAT	CF	ASH	CHO	NDF	ADF	ADL	HMC	CELL
T1	96.15^{c}	12.23^{b}	3.55^{c}	11.62^{e}	10.03^{e}	58.81^{a}	39.62^{e}	20.18^{e}	14.05^{e}	19.44	6.13
T2	97.31^{a}	13.04^{a}	3.59^{b}	15.81^{d}	13.18^{d}	51.69^{b}	39.67^{d}	29.08^{d}	19.03^{d}	10.59	10.05
T3	96.13^{c}	9.12^{d}	2.88^{d}	20.55^{b}	14.86^{c}	48.69^{c}	43.76^{b}	34.38^{c}	21.93^{c}	9.38	12.45
T4	97.20^{b}	11.47^{c}	3.92^{a}	20.94^{a}	15.26^{b}	45.61^{e}	44.12^{a}	42.25^{b}	29.55^{a}	1.87	12.7
T5	97.31^{a}	7.59^{e}	2.42^{e}	19.50^{c}	17.15^{a}	50.64^{c}	42.12^{c}	42.34^{a}	27.95^{b}	0.22	14.39
S.E.M	1.52	5.77	4.47	5.38	1.55	4.94	5.37	5.38	5.28	0.01	5.38
P-value	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Treatmt= Treatment; WB=Wheat Bran, RH-Rice Husk, DM= Dry matter, CP= Crude protein, CFAT=Crude Fat, CF=Crude fibre, CHO= Carbohydrate, NDF= Neutral detergent fibre, ADF= Acid detergent fibre, ADL= Acid detergent lignin, HMC= Hemicellulose, CELL= Cellulose, T1 (RH0%), T2 (RH25%), T3 (RH50%), T4 (RH75%), T5 (RH100%).

Table 3: *Invitro* gas production volume (ml/200 mg DM) of feed samples at different incubation period.

Incubation Period (hrs.)	Treatments (ml/200 mg DM).						
	T1	T2	T3	T4	T5	SEM	*p*-value
3hrs	12.33	9.33	6.33	8.67	5.67	1.86	0.1641
6hrs	17.67	14.00	10.33	11.67	10.00	1.93	0.0924
9hrs	21.67	17.67	14.33	15.00	12.33	2.63	0.1899
12hrs	23.67	19.33	16.67	17.67	12.33	2.74	0.1350
15hrs	25.67	22.33	18.67	19.00	12.33	2.24	0.0190
18hrs	28.00	25.33	23.00	19.33	14.00	2.20	0.0092
21hrs	31.00	29.00	25.67	22.33	19.00	1.89	0.0072
24hrs	31.67	30.33	25.67	22.33	19.00	2.07	0.0072
GV	29.33	28.33	23.67	20.33	18.33	2.06	0.0119

T1=0%Rice husk, T2=25%Rice husk, T3=50%Rice husk, T4=75%Rice husk, T5=100%Rice husk, GV=Gas volume, abcde= Means with the same letters within the column are not significantly different (p > 0.05), SEM= Standard error of mean.



1=T1,0%RH, 2=T2,25%RH, 3=T3,50%RH, 4=T4,75%RH, 5=T5,100%RH.

Figure 1: The methane (CH_4) production of West Africa dwarf goats fed experimental diets