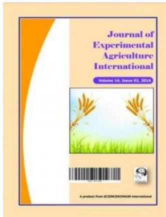

Journal of Experimental Agriculture International

17(1): 1-10, 2017; Article no.JEAI.34398
Previously known as American Journal of Experimental Agriculture
ISSN: 2231-0606

Performance of West African Dwarf Goats Fed *Pleurotus tuber-regium* Biodegraded Rice Straw and Maize Offal: Brewer Yeast Slurry Mixture

A. A. Wuanor[1*] and J. A. Ayoade[2]

[1]Department of Animal Nutrition, University of Agriculture, Makurdi, Nigeria.
[2]Department of Animal Production, University of Agriculture, Makurdi, Nigeria.

Authors' contributions

This work was carried out in collaboration between both authors. Author AAW wrote the protocol, carried out the practical work, managed the analyses of the study, managed the literature and wrote the first manuscript while author JAA designed and supervised the study and also edited the first manuscript. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JEAI/2017/34398
Editor(s):
(1) Özge Çelik, Department of Molecular Biology and Genetics, Istanbul Kultur University, Turkey.
Reviewers:
(1) Leonor Almeida De Souzasoares, Universidade Federal do rio Grande, Brazil.
(2) Dany Cinq-Mars, Université laval, Canada.
Complete Peer review History: http://www.sciencedomain.org/review-history/20255

Original Research Article

Received 26th May 2017
Accepted 19th July 2017
Published 28th July 2017

ABSTRACT

Aim: To assess the growth performance of West African Dwarf Goats (WAD) fed rice straw biodegraded using *Pleurotus tuber-regium* (PTTRS) and maize offal mixed with fluid brewers' yeast slurry in a 1:1 ratio (MOBYS).
Study Design: Completely Randomized Design.
Place and Duration of Study: The study was conducted at the Sheep and Goat Unit section of the University of Agriculture Makurdi Livestock Teaching and Research Farm, Makurdi, Nigeria. Makurdi is located at Latitude 7º 43¹ N and Longitude 8º 31¹ E. The Experiment lasted for 90 days.
Methodology: Twenty four West African Dwarf (WAD) goats weighing 8.05 kg on the average were allotted to six groups of four goats per treatment in a completely randomized design for the study. The six dietary treatment groups were fed varying levels of MOBYS, and *ad libitum,* untreated rice straw (UTRS) and *Pleurotus tuber-regium* treated rice straw (PTTRS) thus: T1= 100 g MOBYS and UTRS (control) *ad libitum,* T2=100 g MOBYS and PTTRS *ad libitum*, T3=200 g MOBYS and UTRS *ad libitum*, T4=200 g MOBYS and PTTRS *ad libitum*, T5=300 g MOBYS and

**Corresponding author: E-mail: alexwuanor@yahoo.com;*

UTRS *ad libitum*, and T6=300 g MOBYS and PTTRS *ad libitum.* Parameters measured were Average daily feed intake (ADF), Average Daily body Weight Gain (ADBWG), Feed Conversion Ratio (FCR) and Average daily water intake (ADWI).
Results: Fungal treatment of rice straw together with MOBYS significantly (P=.05) improved the daily feed intake, daily body weight gain and daily water intake from 224.20 g to 396.10 g, 13.20 g to 27.20 g and 620 ml to 1050 ml in T1 and T6 respectively.
Conclusion: Combined feeding of the PTTRS and MOBYS to goats in confinement significantly improved feed intake, body weight gain, water intake and feed conversion ratio thereby portraying the feeding regime as a reliable dry season feed.

Keywords: Performance; goats; Pleurotus tuber-regium; biodegraded; rice straw.

1. INTRODUCTION

The growing human population has put a challenging responsibility on all stakeholders in the food production sector. This has necessitated research into tools for producing food to feed the ever increasing world population. Globally, there is an urgent need to increase livestock to meet the animal protein needs of the world's increasing population [1]. Shortages in availability and consumption of animal protein by Nigerians are worrisome due to its attendant effects on the citizenry [2]. For Nigerians to improve their animal protein intake, sustained production of livestock has been suggested [3]. Of these livestock, goat production is recommended due to its beneficial effects, some of which include provision of meat, milk, skin and hair, as a form of investment, assurance against crop failure, prestige, sources of income and employment [4]. The population of goats in Nigeria has been put at 53.8 million and were reported to have contributed 16% of the total domestically produced meat in the country [5]. If these goats are well managed; they would substantially contribute their products and increase Nigerians animal protein consumption profile [4].

The nutritional constraint to goat production is two way; availability of feed as well as quality of the feed. To overcome availability of ruminant feeds on a year round basis, the combined use of crop residues and agro industrial by-products is being researched on [6]. Nigeria, being an agrarian nation, produces large quantities of crop residues each year after harvest, and as the crops are processed by agro based industries, agro industrial by products are generated which need to be eliminated. One crop residue produced in abundance in the country is rice straw [7]. Rice straw, the vegetative part of rice plant which is left after grains have been harvested [8] is highly fibrous, low in digestibility, protein content and palatability and high in oxalate content.

White rot fungi have been used extensively in recent times to investigate their effectiveness in converting lignocellulose materials to more digestible feeds for ruminants. Fungal degradation of crop residues is thought to have dual advantages of increased global food production and waste cycling [9]. Improvement in nutritive quality of biologically treated crop residues and agro industrial by products has also been reported by [10,11,12] amongst others.

Two by-products of agro processing industries that abound in the country are maize offal and brewer yeast slurry. Maize offal is a product of maize processing. Its feed value is low and therefore cannot be fed solely to animals for production unless when supplemented with a protein source [13]. Brewer yeast slurry is a fluid by product of the beer brewing industry made up of spent yeast cells (*Saccharomyces cerevisae*). Once it is dried using an appropriate technique, it has high nutrient content and has been effectively used as a feed input [14].

The study was carried out to evaluate the performance of West African Dwarf goats (WAD) fed biologically treated rice straw and maize offal: brewer yeast slurry mixture.

2. MATERIALS AND METHODS

2.1 Experimental Site

The study was conducted at the Sheep and Goat Unit of the Livestock Teaching and Research Farm of the University of Agriculture, Makurdi, Nigeria. Makurdi is located at Latitude 7º 43¹ N and Longitude 8º 31¹ E. The Experiment lasted for 90 days.

2.2 Processing of Experimental Feed Materials

Rice straw was gathered from rice farms around University of Agriculture, Makurdi environs after rice was harvested and threshed. It was baled and kept in store to prevent rain water from possibly wetting and spoiling it. Later, the rice straw was milled using a blur mill to reduce its particle size and create a greater surface area for microbial activity. The milled straw was then put in sacks and stored until required for use.

2.2.1 Mass composting of rice straw for experimental feeding of goats

Floors, walls and doors of the inoculation room were swept, washed and disinfected using Dettol disinfectant (Formula: Chloroxylenol B.P.C 4.8% w/v, Oleum Pini Aromaticum 8.38% w/w, Isopropyl Alcohol 9.43% w/w, Sapo Vegetalis 5.60% w/w, Saccharum Ustum q.s, Aqua ad 100 vols., manufactured by Reckitt Benckiser, Nigeria Limited) in water at the rate of one liter Dettol to four liters of water. The floors were then mopped free of water and the doors left open for one week to enable drying of the room.

2.2.2 Composting of milled rice straw

The milled rice straw was wetted with water at the rate of 1.0 kg straw to 2.0 liters of water and thoroughly mixed to enable complete wetting of the straw. Then the straw was heaped in one place and covered using polyethene sheets to create an airtight environment suitable for composting [15]. The straw heap was turned inside out every other day for a total period of seven days after which the heap was spread out to enable cooling of the composted straw.

2.2.3 Fungal inoculation of the straw

Tubers of *Pleurotus tuber-regium* (PTR), obtained from dealers were weighed, washed and soaked in water for one hour after which they were removed and put in white transparent buckets and covered for two days to enable spore formation of the tubers. After two days, the PTR were removed and dissected to smaller bits carrying the spores. The composted straw was loaded on three tier wooden trays of dimension 1.5 m x 1.2 m x 0.75 m (height, breadth and width) constructed using 2x2" wood and wire mesh base. The base of the wooden tray was covered with white transparent polyethene sheet disinfected using methylated spirit soaked cotton wool. Spores of PTR were then inoculated into the composted rice straw at the rate of 1.0 kg spores to 5.0 kg straw. The ends of the polyethene sheets were then brought together and sealed using masking tape to create an airtight environment. Water was then poured on the room floor and some left in buckets after which doors of the inoculation room were closed. After 30 days, the mass of composted straw now colonized by mycelium of the fungi showing whitish growths was taken out of the inoculation trays from the inoculation room and sun dried by spreading it thinly on a drying surface to terminate growth of the fungi and dry the material. The material was then put in sacks and stored until required for use.

2.2.4 Maize offal: Brewer yeast slurry mixture (MOBYS) preparation

Maize offal was bought from mills, sun dried and stored in sacks. Brewer yeast slurry was collected from Benue Brewery Limited, moved to the drying site and mixed with maize offal in the ratio of 1:1 by weight and sun dried with constant turning to prevent lumps from following. After sun drying, the mixture (MOBYS) was then put in sacks and stored.

2.3 Proximate Composition and Fibre Fractions Analysis of Feed Materials

Dry matter (DM) was determined by oven drying the milled samples to a constant weight at 105ºC for 8 hours. Crude protein was determined as Kjeldahl nitrogen x 6.25. Ether extract, crude fibre and ash were determined according to [16] method; gross energy was determined by use of bomb calorimeter while the fibre fractions were determined by use of [17] method.

2.4 Goat Pen Preparation

The goat pen having cages for individual housing and feeding of the goats were used. The individual cages were constructed using 2x2" wood with lockable doors. Dimensions of the cages were 1.27 m x 1.2 m x 0.7 m (height, breadth and width). The cages were thoroughly swept, washed, disinfected and left to dry. The entire pen was then fumigated using Sniper (2, 3 – dichlorovinyl dimethyl phosphate) and Marshal (Lambda – cyhalothrin 2.5 EC) at the rate of 3 ml to 200 ml water and 20 ml to 20 liters water respectively. The feeding troughs were constructed using wooden planks and were of the dimension 0.25 m x 0.25 m x 0.30 m (height, breadth and width).

2.5 Acquisition of Goats/ Acclimatization

24 Young WAD bucks weighing 8.05 kg on the average were sourced from areas of the state where vaccination against Pestes des Petit ruminants (PPR) had been carried out and conveyed to the farm. They were then exposed to a 30 day acclimatization period during which they were given prophylactics against endo and ectoparasites and a general antibiotic cover thus: Tridox L.A. (each ml solution contained 216 mg oxytetracycline dehydrate equivalent to 200 mg oxytetracycline; manufactured by FARVET laboratories Handelsweg 25, 5531 AE Bladel, Holland) @ 1.0 ml per goat administered intramuscularly; kepro vitaflash injectable multivitamins (composition per ml: vitamin A 4,500 iu; vitamin D3 1,000 iu; vitamin E acetate 10 mg; vitamin B1 HCL 12 mg; vitamin B2 Phosphate sodium 2.0 mg; vitamin B6 HCL 10 mg; vitamin B12 5.0 µg; Folic Acid 0.1 mg; vitamin K3 1.0 mg; Nicotinamide 20 mg; vitamin C 1.0 mg D-Panthenol 1.0 mg; manufactured by KEPRO B.V. Maagdenburgstraat 17 7421 ZA Deventer Holland) @ 0.5 ml per goat administered sub cutaneously, Pour on (100 ml contained: Cipermetine 5.0 g; Chlorpyrifos 7.0 g; Piperonile Butoxide 5.0 g; Citronellol 0.5 g; Qsp 100 ml) @ 1.0 ml per goat administered at backline of the goats, Ivomec (ivermectin 1.0%) @ 1.0 ml per 10kg live weight administered sub cutaneously and iron Dextran injection (each ml solution contained iron dextran equivalent to 100 mg iron; manufactured by Hebei Huarun Pharmacy Co., Ltd. No. 83, East Gucheng Road, Shijiazhuang, Hebei, China) @ 1.0 ml per goat administered intramuscularly.

They were then randomly allocated to the six dietary treatments and caged individually.

2.6 Feeding of Experimental Goats

After acclimatization period, the goats were then exposed to the following dietary treatments for 90 days:

T1 = 100 g MOBYS and untreated straw (RS) *ad libitum*
T2 = 100 g MOBYS and *Pleurotus tuber-regium* treated rice straw (PTRRS) *ad libitum*
T3 = 200 g MOBYS and RS *ad libitum*
T4 = 200 g MOBYS and PTRRS *ad libitum*
T5 = 300 g MOBYS and RS *ad libitum*
T6 = 300 g MOBYS and PTRRS *ad libitum*

Four goats were used per treatment with each goat forming a replicate. The goats were also served water and Yalama Blogu Royal Mineral Licking Block *ad libitum.* Their drinking water and MOBYS were put in poultry chick drinkers and inserted into the feeding troughs while the untreated rice straw and PTTRS were served directly in the feeding troughs.

2.7 Performance Indices Assessment

Weighed quantities of the feed and water were offered to the goats daily and intake was determined from the refusals collected the following day and weighed. Body weight observations were taken weekly on the first day of the week before feeding was done. Feed conversion ratio was calculated using the formula FCR = Total feed intake (g)/ Total weight gain (g).

2.8 Data Analysis

Data generated was subjected to Analysis of Variance (ANOVA) using MiniTab Statistical Software and significant differences (at 95% probability) in means were separated using Duncan New Multiple Range Test as outlined by [18].

3. RESULTS

3.1 Nutrient Profile of Feed Materials

The nutrient profile of experimental feed materials is shown in Table 1 while the fibre fractions are shown in Table 2. The proximate composition shows that there was an increase in dry matter (DM), crude protein (CP), ash, and gross energy (GE) when *Pleurotus tuber-regium* was used to treat rice straw (RS), while the crude fibre (CF), ether extract (EE) and nitrogen free extracts (NFE) decreased as a consequence of the fungal treatment.

3.2 Growth Performance

Results of growth performance of WAD goats fed PTTRS supplemented with MOBYS is presented in Table 3. There was no significant difference (P=.435) in the initial body weights of the goats but final body weights of goats in T5 and T6 were higher and significantly different (P=.00) from those of T3 and T4 which were also higher and significantly different (P=.00) from those of T1 and T2. Daily rice straw and PTTRS intakes did not differ significantly (P=.32) among the dietary treatments. Mean daily total feed intake of T6 was highest and significantly different (P=.00) from the other treatments. This was followed by the other treatments in the order of T5, T4, T3, T1 and T2 which were significantly different (P=.00) from each other. Percent dry matter feed intake increased with increasing total daily feed intake and followed the order of T6, T5, T4, T3, T1 andT2; it showed significant difference (P=.00) where T6 and T5 were the highest and similar to each other, but significantly different (P=.00) from the other treatments. This was followed by T4 and T3 which were similar to each other but significantly (P=.00) different from T2 and T1 which were similar to each other. Mean daily metabolic rice straw intake and mean daily metabolic PTTRS intakes did not differ (P=.28) significantly among the dietary treatments. Mean daily metabolic MOBYS intake and Mean daily metabolic total feed intakes followed the patterns of mean total daily MOBYS intake and mean total daily feed intake. Values of mean daily body weight gain recorded for T5 and T6 were the highest and significantly different (P=.00) from the rest followed by T3 and T4 which were also higher and significantly different (P=.00) from those of T1 and T2 which were the least and similar to each other. This pattern of performance was followed by mean daily metabolic body weight, total body weight gain as well as total metabolic body weight gain. Feed conversion ratios of T1 and T2 were the highest but values for all the treatments were not significantly different (P=.18) Mean daily water intake also followed the pattern exhibited by mean daily body weight gain.

3.3 Nutrient Intake (Dry Matter Basis)

The nutrient intake on dry matter basis by the WAD goats is shown in Table 4. Organic matter intake was highest in T6 being significantly different (P=.03) from the rest of the treatments. It was followed in the order of T5, T4, T3, T1 and T2 which were all significantly different (P=.03) from each other. Highest crude protein intake was recorded for T6, followed by T5, T4, T3, T2 and T1 which were also significantly different (P=.01) from each other. Crude fiber intake was highest for T5 and was significantly different (P=.04) from the remaining treatments, followed by T6 and T4, significantly different from each other and also from T1, T2 and T3 which were statistically similar. Ether extract intake followed the pattern of organic matter intake, except that T1 and T2 were not different (P=.02) from each other. Nitrogen free extracts intakes of T5 and T6 were similar to each other but significantly different (P=.03) from T3 and T4 which were also significantly different from T1 and T2. Ash intake generally followed the pattern of crude protein intake in quantities and statistical significance.

Table 1. Nutrient composition of feed materials (on as fed basis)

Feed material	DM (%)	CP (%)	CF (%)	EE (%)	ASH (%)	NFE (%)	Gross energy (MCal/Kg)
Untreated rice straw	90.13	8.32	34.14	2.91	5.88	48.75	3.32
Treated rice straw*	91.31	11.33	28.78	2.87	10.90	46.12	3.47
Maize offal	90.70	12.19	10.87	2.10	3.89	70.95	3.57
Brewer yeast slurry	15.21	44.08	4.21	1.70	9.36	40.65	3.61
MOBYS**	90.48	25.60	15.6	10.20	9.10	39.50	4.27

**Treated rice straw = Pleurotus tuber-regium treated rice straw*
***MOBYS = Maize offal: Brewer yeast slurry mixture at ratio of 1:1*
DM= Dry Matter; CP= Crude Protein; CF= Crude Fiber; EE= Ether Extracts; NFE= Nitrogen Free Extracts

Table 2. Fibre fractions of the feed materials

Fibre fraction	UTRS	PTTRS	MOBYS
NDF (%)	72.06	77.43	22.5
ADF (%)	51.31	6.14	13.15
ADL (%)	11.39	1.43	1.07
HEM (%)	20.75	71.29	9.35
CL (%)	39.92	4.71	12.08

NDF= Neutral Detergent Fibre; ADF= Acid Detergent Fibre; ADL= Acid Detergent Lignin; HEM= Hemicellulose; CL= Cellulose; UTRS=Untreated Rice Straw; PTTRS=Pleurotus tuber-regium Treated Rice Straw; MOBYS=Maize Offal: Brewer Yeast Slurry Mixture

Table 3. Performance of WAD goats fed fungal treated rice straw and maize offal: Brewer's yeast mixture

Parameter	T1	T2	T3	T4	T5	T6	SEM
Initial B.W. (Kg)	8.10	8.25	8.20	8.15	8.25	8.10	0.07
Final B.W (Kg)	9.29^c	9.42^c	9.95^b	10.02^b	10.62^a	10.55^a	0.09
D. RS intake (g)	128.50	-	120.60	-	115.30	-	4.22
D. PTTRS intake (g)	-	115.60	-	119.50	-	110.50	2.62
D. MOBYS intake (g)	95.70^e	96.20^e	174.70^d	187.74^c	270.20^b	285.60^a	4.79
D. TF. intake (g)	224.20^e	211.80^f	295.30^d	307.24^c	385.50^b	396.10^a	3.56
DM feed intake (%)	2.18^c	2.04^c	2.68^b	2.78^b	3.28^a	3.41^a	0.001
Total FI (Kg)	$20{,}178^e$	$19{,}062^f$	$26{,}577^d$	$27{,}652^c$	$34{,}695^b$	$35{,}649^a$	425.52
D. RS intake m	38.16	-	36.38	-	35.14	-	0.94
D. PTTRS intake m	-	35.25	-	36.14	-	34.07	0.61
D. MOBYS intake m	30.59^e	30.72^e	48.03^d	50.72^c	66.63^b	69.47^a	0.92
D. TF intake m.	57.93^e	55.52^f	71.23^d	73.38^c	87.00^b	88.79^a	0.64
D.BWG(g)	13.20^c	13.00^c	20.00^b	20.80^b	26.30^a	27.20^a	1.03
T.BWG m.	6.92^c	6.85^c	9.45^b	9.74^b	11.61^a	11.90^a	0.36
T.BWG (Kg)	1.19^c	1.17^c	1.17^c	1.87^b	2.37^a	2.45^a	0.07
T. BWG m	1.14^c	1.12^c	1.52^b	1.60^b	1.91^a	1.96^a	0.05
FCR	16.96	16.29	15.19	14.79	14.64	14.55	0.79
D.WI (ml)	620^c	615^c	850^b	890^b	1030^a	1050^a	30.97

***MOBYS = Maize offal: Brewer yeast slurry mixture at ratio of 1:1*
a,b,c,d,e---- Means on same row with different superscripts vary significantly (P=.05)
T1, T3 and T5 fed MOBYS and rice straw
T2, T4 and T6 fed MOBYS and PTTRS
PTTRS = Pleurotus tuber-regium Treated Rice Straw; m= Metabolic Weight; WI= Water Intake
RS= Rice Straw; TF= Total Feed; BW= Body Weight; D= Daily; BWG= Body weight gain;
FCR = Feed Conversion Ratio

Table 4. Nutrient intake of WAD goats fed fungal treated rice straw supplemented with maize offal: brewer yeast slurry mixture (g) (dry matter basis)

Nutrient	T1	T2	T3	T4	T5	T6	SEM
DM (%)	202.43^e	192.60^f	266.77^d	278.98^c	349.05^a	359.31^a	3.29
OM (%)	168.03^a	155.70^f	220.21^d	225.97^c	286.49^b	291.42^a	2.62
CP (%)	31.88^f	34.23^e	49.50^d	55.84^c	71.23^b	77.57^a	0.95
CF (%)	60.54^c	43.96^c	62.05^c	57.89^d	73.88^a	69.34^b	1.17
EE (%)	12.39^e	12.10^e	19.64^d	0.84^c	28.50^b	29.83^a	0.39
NFE (%)	90.36^c	83.06^d	115.14^b	117.42^b	146.96^a	148.61^a	1.32

^{a,b,c,d,e,f}---- Means on same row with different superscripts vary significantly (P=.05)
T1, T3 and T5 fed MOBYS and untreated rice straw
T2, T4 and T6 fed MOBYS and Pleurotus tuber-regium treated rice straw
DM = Dry Matter; OM = Organic Matter; CP = Crude Protein; CF = Crude Fibre;
EE = Ether Extract; NFE = Nitrogen Free Extracts

4. DISCUSSION

4.1 Nutrient Composition of Feed Materials

The dry matter of the rice straw used in this study is lower than those reported by other workers [19,20,21] but higher than reports of [8] but generally falls within the range given by [22]. The higher DM is advantageous, meaning less moisture and more nutrients. According to [23], dry matter is the portion of the feed material that contains the nutrients. The percentage compositions of crude protein of this rice straw is higher than values reported by other authors [24,8] but falls within the range of 2-9% given by [22]. This difference is explained by nitrogen fertilization of the rice farm. [8] reported that higher nitrogen fertilization of the rice plants yield higher crude protein in the straw. The crude fibre, ether extract and NFE values also fell within the range value of 20-45%, 1-4% and 29-48% respectively reported by [22]. The ash content falls lower than values reported by [22]. This variability could be attributed to higher values of the other proximate components on one side and the report by [8] that geographic location of the rice field in the rice growing region and days between harvest and baling of the straw affect nutritive quality of rice straw.

The dry matter, crude protein, and gross energy of the *Pleurotus tuber-regium* treated straw were higher than that of the untreated straw while the crude fibre, ether extract and NFE were lower than those in the untreated straw. In principle, this shows an enhancement of nutritive quality. Similar reports of reduction in some proximate components and increase in others have been reported by [11]. Increases in some proximate components are attributed to higher nutritive values of the fungal biomass coupled with protein contents of the enzymes, while reductions are attributed to the fact that the fungus itself needs nutrients to survive and carry on with its developmental stages. Reduction in crude fibre of biologically treated feed materials has been attributed to the ligninolytic enzymes which degrade the lignin and other fibre components thereby rendering the residue less fibrous. [25] stated that increase in crude protein of fungal treated crop residues could be explained by increased fungal biomass and secretion of extra cellular enzymes which are proteinous in nature into the residues during their breakdown and subsequent metabolism. The author also explained that decrease in ether extract of the fungal treated material could be caused by consumption of some fatty acids by the fungus as a suitable energy source for growth.

4.2 Performance Indices

The average daily rice straw intake of goats in the various treatments did not differ significantly, but showed a trend of decreased intake as the amount of MOBYS offered increased. This non significant rice straw intake is reasoned to be caused by its fibrous nature. The intake values are lower than those reported by [19] (except T1) which also showed significant difference in intake. It has been reported that the fibrous nature of rice straw limits its intake by animals [26,27] because gut fill is experienced quickly.

The average daily PTTRS intake did not also differ significantly among the treatment groups. Its low intake, despite enhancement in nutritive value shown by increased DM, CP, Ash and GE, and decreased CF and NFE is reasoned to be caused by the smell of the PTTRS, because it absorbed the smell of the *Pleurotus tuber-regium*. Goats, being inquisitive feeders and fastidious [28,29] usually do not eat much of feed which they do not relish the smell.

The average daily MOBYS intake pattern showed that the higher the intake of either RS or PTTRS, the lower was the MOBYS intake. With respect to intakes of either RS or PTTRS, higher intakes of MOBYS were recorded for the PTTRS than the RS fed groups, where intake of the PTTRS fed groups was 96.2, 93.87 and 95.2% compared to 95.7, 87.35 and 90.07% of the RS fed groups. That all the groups were not able to exhaust the amount of MOBYS offered is attributed to unique feeding habits of goats. In confinement, goats devote less time to feed intake causing low feed intake [30]. This explanation is most plausible, because, on some days the goats would eat just a little quantity of feed despite no sign of ill health while on some other days finish the daily ration, especially of the MOBYS. The tantalizing aroma of the MOBYS coupled with its reported bitter taste [14] were reasoned to be added advantage because goats have been reported to relish eating bitter feeds [28], moreover, feed intake in ruminants is influenced by a taste related attribute. The high crude protein of the MOBYS (25.6%) may also have placed a ceiling on its intake. In goats, one of the factors affecting feed intake is dietary crude protein.

The mean daily total feed intake picture shows an increasing trend as PTTRS was fed (except T2) and as amount of MOBYS offered increased. The total daily feed intake was actually a cumulative intake of RS, PTTRS and MOBYS, so followed the pattern of intake of cumulative amounts of combinations of the feeds offered.

The percentage dry matter intake of the experimental animals is low compared to the values of 3-5% body weight [23] or 4.1 to 6.0% [31] or the reported value of 4.1 to 5.67 % by [32].

Average daily body weight gain values obtained in this work had a direct relationship with the intakes of RS, PTTRS and MOBYS. In general, the weight gain improved with PTTRS intake as against RS (except T2) and increased MOBYS intake. This pattern of BWG is reasoned to be a direct response to nutrient availability and intakes, which would have been converted to body weight. [33] had reported that superior body weight of goats could be caused by diets providing the best balance of nutrients for growth and [34] reported that plane of nutrition markedly affects BWG. Values of BWG reported here are superior to those reported by [13], comparable to those of [35,31] and inferior to those reported by [36].

The feed conversion ratio values herein are better than those of [37], less than those of [38]. In general the FCR values show efficiency of utilization of the dietary combinations by goats.

The final body weight values showed an increasing trend as amount of MOBYS offered increased and reflect availability of nutrients for body building. The values are comparable to those of other workers [39,40].

The average daily water intake had a direct bearing on MOBYS and PTTRS intakes. Increased MOBYS intake as well as intake of PTTRS caused higher water intake (except T2). The significant effect as well as amount of water intake agrees with the work of [41]. Water intake values also compared with reports of other workers [42,43]. In general water is needed in protein digestion, and the higher the protein taken, the higher the amount of water required for protein digestion and the hydrolysis that continually goes on in cells [44].

4.3 Nutrient Intake (Dry Matter Basis)

The dry matter, organic matter and crude protein intakes of the experimental groups showed a pattern of increased intake as the amount of MOBYS intake increased, also it was better for the PTTRS than the RS fed groups (except T2 in case of dry matter and organic matter). The significant effect on dry matter intake agrees with the reports of [13] and [45] but contrasts the work of [35]. The values of DMI compare with values reported by [13]. The significant effect of organic matter and crude protein intakes agree with report of [45] but disagree with [35].

5. CONCLUSION

It was concluded that combined feeding of the fungal treated rice straw and MOBYS to goats in confinement significantly improved feed intake, body weight gain and water intake, thereby portraying the feeding regime as a useful alternative and reliable dry season feed.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Atteh JO. Developing strategies for adding value to local livestock feed Paper presented at plenary session of the 16th annual conference of Animal Science Association Nigeria. 2011 Held at Kogi State University, Anyigba.
2. Wuanor AA. Performance, haematology, serum biochemistry, carcass yield and production economics of West African Dwarf goats fed *Pleurotus tuber-regium* degraded rice straw and maize offal: brewer yeast slurry mixture. Ph.D Thesis, University of Agriculture, Makurdi; 2014.
3. Chidebelu SND, Ngo NM. The economics of goat production in south Eastern Nigeria: Implications for the future. Nigerian Journal of Animal Production. 1998;25(1):93-99.
4. Ayoade JA. Poor Man's cow: Sheep and goats. Inaugural lecture series 11, August 25th 2010, University of Agriculture, Makurdi, Nigeria.
5. Nuru S. Problems and prospects of Nigeria's beef industry. In: Beef production In Nigeria. Proceedings of the national conference on beef production held in Kaduna, Nigeria, 27th – 30th July 1982. (Eds: Osinowo, O.A., Ikhatua, U.J. and Ehoche, W.O.).
6. Onwualu PA. Enhancing competitiveness of the Nigerian Livestock sub sector through improved value addition on the industry value chain. Paper presented at 16th Annual Conference, Animal Science Association of Nigeria 12th -15th Sept 2011 held at Kogi State University, Anyigba.
7. Ngi J. Evaluation of dried cassava leaf meal and maize offal as concentrate supplement for goats fed rice straw. M.Sc. Thesis, University of Agriculture, Makurdi, Nigeria; 2005.
8. Drake DJ, Nader G, Forero L. Feeding rice straw to cattle. University of California Division of Agriculture and natural Resources; 2002.
   Available:http:///anrcatalog.Ucdavis.edu
   (Retrieved 8th January, 2013)
9. Banjo NO, Opere BO, Abaja ZA. Comparison of growth and yield of oyster mushroom (*Pleurotus pulmonarius*) on three varieties of sawdust. Nigerian Food Journal. 2003;21:129-132.
10. Zadrazil F. Conversion of lignocellulosics wastes into animal feed with white rot fungi. Proceedings of International Conference on Mushroom Biology; 1993.
11. Akinfemi A, Mohammed MI, Ayoade JA. Biodegradation of cowpea shells by *Pleorotus* species for its use as ruminant

feed. World Journal of Agricultural Sciences. 2009;5(5):639-645.
12. Akinfemi A, Muktar RI. Changes in chemical composition and *in vitro* digestibility of fungal treated bagasse. Proceedings, 17th Annual Conference, Animal Science Association of Nigeria 9th – 13th Sept 2012 held at Abula; 2012.
13. Ahamefule FO, Ibeawuchi JA, Elendu C. Intake and digestibility by West African Dwarf goats bucks fed cassava leaf-maize offal based diets. Proceedings, 32nd Annual Conference, Nigerian Society for Animal Production, 18th -21st March, Calabar; 2007.
14. Ikurior SA, Akem JD. Replacing maize with cassava root meal or its mixture with brewer's yeast slurry in rabbit diets. Nigerian Journal of Animal Production. 1998;25(1):31-35.
15. Oei P. Mushroom cultivation. With special emphasis on appropriate techniques for developing countries. CTA series. Tool publications, Leiden; 1996.
16. AOAC. Association of Official Analytical Chemists. Official Methods of Analysis (Ed. W. Horowitz) 18th Edition. Washington, D.C; 2005.
17. Van Soest PJ, Robertson JB, Lewis BA. Methods for dietary fibre, neutral detergent fibreet al 1991.
18. Steel RGD, Torrie JH. Principles and procedures of statistics. New York, McGraw-Hill Book Company; 1980.
19. Ayoade JA, Akogwu JEE, Okewu J. Comparative performance of sheep and goats fed untreated rice straw supplemented with a mixture of maize offal/milling waste (1:1). In: Adedzwa and J.Y. Odiba (ed). Book of reading on available technologies for transfer. Aboki Publishers; 2003.
20. Castillo LS. Current utilization of fibrous residue in Asian countries. In: *The* utilization of fibrous agricultural residues. Australian development seminar assistance bureau research for development seminar, Los Banos, Philippines, 18th-23rd May; 1981.
21. Shen HS, Ni DB, Sundstol F. Studies on untreated and urea treated rice Straw from three cultivation seasons: 1. Physical and chemical measurements in straw and straw fractions. Animal Feed Science. 1998;73:243-261.
22. Smith DO. On farm treatment of straws and stovers. In: Development and field evaluation of animal feed supplementation packages. Proceedings of the final meeting of an IAEA Technical Cooperation Regional AFRA project organized by joint FAO/IAEA Division of Nuclear Techniques in food and Agriculture, held in Cairo, Egypt, 25th-27th November 2000. IAEA-TECDOC-1294.
23. Mowlem A. Goat farming. Farming Press Books, Wharfedale Road, UK; 1992.
24. Meng Q. Composition, nutritive value and upgrading of crop residues. FAO Corporate Document Repository; 2002.
25. Akinfemi A, Babayemi OJ, Jonathan, SG. Bioconversion of maize husk into value added ruminant feed by using white rot fungus. Revista UDO Agricola. 2009;9(4): 972-978.
26. Conrad HR. Symposium on factors influencing the voluntary intake of herbage by ruminants: Physiological and physical factors limiting feed intake. Journal of Animal Science. 1996;25:227-235.
27. Sarklong C, Cone JW, Pellican W, Hendriks WH. Utilization of rice straw and different treatments to improve its feed value for ruminants: A review. Asian-Australian Journal of Animal Science. 2010;23(5):560-692.
28. Alaku SO. Introduction to Animal Science. Jee Communications, Ogui Road, Enugu; 2010
29. Baba DM, Yelwa JM, Dabai JS, Sakaba AM. Economics of goat production in Zuru Local Government area of Kebbi State, Nigeria. Advances in Arts, Science and Education Research, Science and Education Development Institute. 2013; 3(8):543-548. Available:http://www.Ejournal.Sedinist.Com
30. Ademosun AA, Bosman HG, Jansen HJ. Nutritional studies with West African Dwarf goats in the humid tropics. In: Goat production in the humid tropics (Eds: Smith, O.B. and Bosman, H.G.) PUDOC, Wageningen, Netherlands; 1988.
31. Jansen C, Burg KV. Goat Keeping in the tropics. Agrodok 7. Agromisa Foundation, Wageningen; 2004. The Netherlands.
32. Bamikole MA, Ikhatua UJ. Utilization of melon seed husk in feeding goats. Proceedings, 32nd Annual Conference, Nigerian Society for Animal Production 18th – 21st Sept 2007 held at Calabar.
33. Eniolorunda OO, Jinadu OA, Ogungbesan MA, Bawala TO. Effect of combined levels

of *Panicum maximum* and *Gliricidia sepium* on nutrient digestibility and utilization by West African Dwarf goats fed cassava based diet. Proceedings, 33rd Annual Conference, Nigerian Society for Animal Production 15th -19th Sept. 2008 held at Ahmadu Bello University, Zaria.

34. Devendra C, Burns M. Goat production in the tropics. Commonwealth Agricultural Bureau, Farnham Bough, U.K.; 1993.
35. Ngi J. The nutritive potentials of sweet orange (*Citrus sinensis*) fruit peel meal for goat feeding. Ph.D. Thesis, Department of Animal Production, University of Agriculture, Makudi, Nigeria; 2012.
36. Olatunji JEN, Arigbade ON, Oyebanjo AO, Ajayi OM. Performance of West African Dwarf goats fed diets containing yam peels. Proceedings, 32nd Annual Conference, Nigerian Society for Animal Production 18th -21st March 2007 held at Calabar.
37. Anigbogu NM, Okoye FC, Akpede TP. Production performance of West African Dwarf goats on varying forage/concentrate ratio feeding system. Proceedings, 32nd Annual Conference, Nigerian Society for Animal Production 18th -21st March 2007 held at Calabar.
38. Anigbogu NM, Onyejekwe IE.Direct fed microbe (*Zynomonas mobilis* degraded rice hull) as feed for Maradi goats. Proceedings, 15th Annual Conference, Animal Science Association of Nigeria; 2010.
39. Oni AO, Onwuka CFI, Oduguwa OO, Onifade OS, Arigbede OM and Oni O. Utilization of citrus based diets and *Enterolobium cyclocarpum* foliage (jacq. griesly) by West African Dwarf goats. Proceedings, 32nd Annual Conference, Nigerian Society for Animal Production, 18th -21st March 2007 held at Calabar.
40. Adepoju IA, Babayemi OJ, Adepoju GA. Performance characteristics and Digestibility study of West African Dwarf goats fed with aquatic plants. Proc. 16th Annual Conference, Animal Science Association of Nigeria, 12-15th Sept. 2011 held at Kogi State University, Anyigba.
41. Oduguwa BO, Amole AO, Okwelum N, Shittu OO, Ogunlolu B.T, Olajuyin S.A. Performance and blood chemistry of West African Dwarf goats fed varying levels of pineapple and cassava peels waste basal diet. Proceedings, 17th Annual Conference, Animal Science Association of Nigeria, 9th -13th Sept. 2012 Abuja.
42. Fajemisin AN. Mineral utilization by West African Dwarf goats fed untreated lyre, urea and poultry litter treated corn cob diets. Proceedings, 18th Annual Conference, Animal Science Association of Nigeria, held at Abuja, 8th t0 12th September; 2013.
43. Oloche J, Oluremi, OIA and Ayoade, JA. Performance of WAD goats fed Diets containing graded levels of sweet orange (*Citrus sinensis*) peel meal. Proceedings, 18th Annual Conference, Animal Science Association of Nigeria 8th -12th Sept, 2013 Abuja.
44. Jacobs PC. Water. Microsoft Encartha 2009 (DVD). Redmonds, W.A: Microsoft Corporation; 2008
45. Sodeinde FG, Asalu VO, Akinlade JA, Amao SR, Alalade JA. Voluntary intake, digestibility and performance of West African Dwarf goats fed graded levels of Panicum maximum (Cv T58) and Stylosanthes scabra (Cv Fritzo). Proceedings, 32nd Annual Conference, Nigerian Society for Animal Production 18th -21st March 2007 held at University of Calabar, Nigeria.

Peer-review history:
The peer review history for this paper can be accessed here:
http://sciencedomain.org/review-history/20255