

Weight Gain and Cost Benefit of West African Dwarf Goats Fed *Pleurotus tuber-regium* Biodegraded Cassava (*Manihot esculenta*) peels based diets

Abstract

Aims: To determine the growth gain and cost benefit of West African Dwarf (WAD) goats fed diets containing white rot fungi (*Pleurotus tuber-regium*) biodegraded cassava peels based diets.

Study design: Completely randomized designed experiment.

Place and Duration of Study: The study was conducted at the ruminant farm Unit of the College of Agriculture, Lafia, Nigeria located Latitude N08° 29' 8.66"; Longitude E08° 29' 49.10" and Altitude 164.5 m; in the guinea savannah vegetation. The experiment lasted for 84 days.

Methodology: Twenty intact WAD bucks of aged between 7-9 months and weighing on the average 6.17 ± 0.96 kg were randomly allocated to five treatment diets (T1-T5) containing untreated cassava peels (UCPS) and *Pleurotus tuber-regium* biodegraded cassava peels (PT-CPS) compounded as follows: T1 – 100% untreated cassava peels (UCPS), T2 – 100% *Pleurotus tuber-regium* treated Cassava Peels (PT-CPS), T3 – 75% UCPS + 25% PT-CPS, T4 – 50% UCPS + 50% PT-CPS and T5 – 25% UCPS + 75% PT-CPS. Daily feed intake, weekly weight gain, feed conversion ratio, benefit, cost and cost benefit ratio were evaluated.

Results: Weight gain of WAD bucks fed treatment diets showed significant ($P = .05$) final weight of 13.25 kg by bucks fed 100% PT-CPS diet (T2), and the lowest 8.00 kg for 100% UCPS. Bucks on T2 diets also recorded the highest ($P = .05$) total mean weight gain of 7.08 kg while bucks on control T1 diet had 1.73 kg as total mean weight gain. Weekly feed intake by the bucks were equally highest ($P = .05$) for bucks in T2 (1,749.75 g) and lowest for bucks in T1 (1,501.13 g). Cost per kg feed consumed recorded a significant ($P = .05$) ₦50.66 for 100% PT-CPS diet. Benefit cost ratio (BCR) showed a superior ($P = .05$) 3.38 for bucks fed 100% PT-CPS diet (T2) and lowest BCR value of 0.91 obtained for bucks fed 100% UCPS diet (T1); inferring treatment T1 is not worth adopting. It was concluded that incorporation of 100% of cassava peels (45% of the diet) biodegraded by *Pleurotus tuber-regium* for 21 days had potential economic gain in growing West African Dwarf goats.

Key words: biodegraded, Cassava peels, *Pleurotus tuber-regium*, WAD goats, weight gain

Introduction

Cassava (*Manihot esculenta*, Crantz) is a root crop with underground storage tuber widely cultivated in the tropics and is one of the most important staple food crops grown in tropical Africa. Nigeria is the world

leading producer of cassava, with projected annual production of 60 million tonnes [1]. Cassava peels make up 10% of the total wet weight and could be 20 -35% of the wet weight if the tubers are hand peeled manually [2, 3]. Feed intake has been observed to be governed by dietary crude protein, palatability and other factors like gut fill, body fat and changes in the body chemical constituents [4]. The importance of protein intake as the determinant of performance in ruminants has been strongly emphasized [5]. Inverse relationship exist between dry matter intake and fibre content of feeds that tends to suggest that decreased level of fibre content increases palatability [4].

Cassava peels are lignocellulosic in nature, possessing the components cellulose, hemicelluloses and lignin. Lignin, a heterogeneous polymer structure of the vascular plants is the most abundant renewable material next to cellulose [6]. Lignin plays a key role in the carbon cycle as the most abundant aromatic compound in nature, providing the protective matrix surrounding the cellulose micro fibrils of plant cell walls [7]. This leads to incomplete utilization of lignocellulosics by ruminants as lignin impedes microbial enzymatic attack in the rumen, thereby leading to lowered organic matter digestibility [8] This phenylpropanoid polymer resists chemical or enzymatic degradation to protect cellulose (the most abundant of all naturally occurring organic compounds). For cassava peels to make substantial contribution to ruminant nutrition, it must be treated in some way to improve its nutritional potentials. These treatments could rectify the short comings of the material and make it easier for rumen microbes to attack the fibres [2].

[7, 9] have reported that amongst the various groups of microorganisms that have the capacity to degrade lignin, rotting basidiomycetous fungi are the most efficient lignin degraders in nature. Current research development must look at technologies that are cheap, safe and adaptable in communities or regions where production and processing of cassava is pronounced.

Therefore biodegradation of agricultural waste provides a cheap and safe process in which the wastes like cassava peels are decomposed by mono or mixed cultures of microorganisms under controlled environmental conditions to improve the quality of the wastes. Thus, the use of microbial enzymes to cleave the complex carbohydrates bonds resulting from the process of biodegradation can be used to

improve the nutritional value of non conventional feed ingredients which are readily available leading to increased inclusion of such feeds into ruminant ration. This process will invariably reduce the cost of ruminant production.

The objective of this study was to determine the weight gain of West African Dwarf (WAD) goats fed diets containing fungi (*Pleurotus tuber-regium*) biodegraded cassava peels based diets and to also determine the economic benefit of feeding diets containing fungi biodegraded cassava peels to WAD goats.

Materials and Methods

Experimental Site

The study was conducted at the Farm Unit of the College of Agriculture, Lafia, Nigeria located Latitude N08° 29' 8.66"; Longitude E08° 29' 49.10" and Altitude 164.5 m; in the guinea savannah vegetation, with its sandy loam soil texture [10].

Treatment of Cassava Peels

Fresh cassava peel was obtained from the Family Support Programme's Gari Processing Industry, Shabu – Lafia and sun dried for six days as described by [11]. Treatment of cassava peels (with *pleurotus tuber-regium*) was by inoculation of composted cassava peels with slides of the tuber on a concrete floor at room temperature covered with polythene sheet and allowed to ferment (solid state) for 21 days at 100% relative humidity.

Proximate composition

DM was determined by oven drying the milled samples to a constant weight at 105° C for 8 hours. Crude protein was determined as Kjeldahl nitrogen x 6.25. Ether extracts, crude fibre and ash were determined according to [12] method.

86 Experimental Diets

87 Five diets (Table 1) containing untreated and biodegraded cassava peels were compounded as follows
88 [13]:

89 T1 – 100% untreated cassava peels (UCPS)

90 T2 – 100% *Pleurotus tuber regium* treated Cassava Peels (PT-CPS)

91 T3 – 75% UCPS + 25% PT-CPS

92 T4 – 50% UCPS + 50% PT-CPS

93 T5 – 25% UCPS + 75% PT-CPS

94 **Table 1: Composition of Treatment Diets Table**

Ingredients	T1	T2	T3	T4	T5
(%)					
UCPS	45	-	33.75	22.50	11.25
PT-CPS	-	45	11.25	22.50	33.75
BDG	30	30	30	30	30
SBM	10	10	10	10	10
PKC	12	12	12	12	12
Bone meal	2	2	2	2	2
Premix*	0.5	0.5	0.5	0.5	0.5
Salt	0.5	0.5	0.5	0.5	0.5

95 *Pfizer Premix : Vit A 10,000,000 IU; Vit D3 2,000,000 IU; Vit E 8,000 IU; Vit K 2,000mg; Vit B1 2,000 mg; Vit B2 5,500mg; Vit B6
96 1,200 mg; Vit B12 12 mg; Biotin 30 mg; Folic Acid 600 mg; Niacin 10,000 mg; Pantothenic Acid 7,000mg; Choline chloride 500,000
97 mg; Vit C 10,000mg; Iron 60,000 mg; Mn 80,000 mg; Cu 8,00mg; Zn 50,000 mg; Iodine 2,000 mg; Cobalt 450 mg; Selenium 100
98 mg; Mg 100,000 mg; Anti Oxidant 6,000 mg.

99 **BDG, Dried brewers grain; SBM, Soya bean meal; PKC, Palm kernel cake**

Other feed ingredients were purchased from open market, livestock feed retailers and veterinary service providers within Lafia.

Animal Management

Twenty West African Dwarf (WAD) intact bucks of age between 7-9 months and having an average weight of 6.17 ± 0.96 kg from the small ruminant section of the farm were allocated to five treatments (T1, T2, T3, T4 and T5) diets in a completely randomized design [14]. The bucks were housed in individual pens measuring 1.5 m^2 each with feed and watering troughs. The animals, four per treatment were allowed access to water, mineral salt lick and fed *ad libitum*. The animals were weighed at the beginning of the trial and weekly thereafter for twelve weeks to assess weight changes. Feed intake was determined by subtracting feed remnant from quantity offered daily at 0800 hours. Fourteen days was allowed for the animals to get accustomed the diets before data collection commenced.

Data Collected: Daily feed intake, Weekly weight gain, Feed conversion ratio (feed intake / weight gain)

Cost Benefit Analysis

The potential benefits of biodegrading cassava peels were determined by means of analysis [15]. This simple analysis was focused on the monetary returns that accrued from the feeding trial. It involves calculating the gross benefit and cost, and then the **benefit / cost** ratio (BCR) was determined. The decision rule is if BCR is more than one, the technology was worth adapting but if BCR is less than one, the technology was not worth adapting.

Data Collected: Benefit, Cost, and Benefit cost ratio

Results

Chemical Composition of Treatment Diets

Chemical composition of the experimental diets containing graded levels of *Pleurotus tuber-regium* biodegraded cassava peels is presented in **Table 2**. Significant ($P = .05$) proximate components values were obtained for treatments diet; CP% is significantly ($P = .05$) higher for T2 (23.21), EE% for T1 (3.90),

CF% for T4 (9.85) and ash % for T4 (6.41). However, the phosphorus content of 0.40, 0.53, 0.50, 0.46 and 0.48 for T1, T2, T3, T4 and T5 respectively was not significantly ($P = .05$) different.

Fibre fractions of the treatment diets were all significantly ($P = .05$) different. NDF % is 38.87, 36.56, 38.27, 37.93 and 36.74 for T1, T2, T3, T4 and T5 respectively. This trend shows decrease in NDF with increasing level of *Pleurotus tuber-regium* biodegraded cassava peels in the diet. Similar decreased trend in the content of ADF % was recorded as 21.71, 17.31, 19.03, 18.80 and 17.60% and also for cellulose content as 16.41, 12.81, 13.81, 13.65 and 12.90% for the treatment diets T1, T2, T3, T4 and T5 respectively. Different trend was recorded for the hemicellulose component of the treatment diets, higher values of hemicellulose were observed for diets containing *Pleurotus tuber-regium* biodegraded cassava peels (T2, T3, T4 and T5). The result of ME was 5.87, 7.90, 6.52, 6.96 and 7.14 MJ/kg DM for T1, T2, T3, T4 and T5 respectively, non significant ($P = .05$) differences was observed for ME values

Table 2: Chemical Composition of Treatment Diets

%	T1	T2	T3	T4	T5	SEM
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DM	89.91 ^e	90.17 ^b	90.06 ^c	89.97 ^d	90.23 ^a	0.33
CP	21.72 ^e	23.21 ^a	22.05 ^d	22.53 ^c	22.74 ^b	0.14
EE	3.90 ^a	3.70 ^d	3.67 ^e	3.78 ^b	3.73 ^c	0.22
CF	10.77 ^a	9.91 ^d	10.53 ^b	9.85 ^e	9.94 ^c	0.10
Ash	6.23 ^c	6.29 ^b	6.28 ^b	6.17 ^d	6.41 ^a	0.22
Ca	0.78 ^c	0.81 ^a	0.81 ^a	0.80 ^b	0.80 ^b	0.003
P	0.40 ^a	0.53 ^a	0.50 ^a	0.46 ^a	0.48 ^a	0.12
NDF	38.87 ^a	36.56 ^e	38.27 ^b	37.93 ^c	36.74 ^d	0.32
ADF	21.71 ^a	17.31 ^e	19.03 ^b	18.80 ^c	17.60 ^d	0.42
ADL	5.30 ^a	4.70 ^d	5.27 ^b	5.15 ^c	4.69 ^d	0.09
Hemicellulose	18.16 ^d	19.25 ^a	19.20 ^b	19.13 ^c	19.14 ^c	0.11
Cellulose	16.41 ^a	12.81 ^e	13.81 ^b	13.65 ^c	12.90 ^d	0.35
ME (MJ/Kg DM)	5.87 ^a	7.90 ^a	6.52 ^a	6.96 ^a	7.14 ^a	0.19

150 a,b,c,d,e – Means on the same row with different superscripts are significantly (P<0.05) different

151 CP –Crude Protein.

152 EE –Ether Extract

153 CF –Crude Fibre

154 NDF – Neutral Detergent Fibre

155 ADF – Acid Detergent Fibre

156 ADL – Acid Detergent Lignin

157 SEM – Standard Error of Mean

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160 **Weight gain of WAD Bucks Fed Treatment Diets**

Weight gain and feed conversion parameters of WAD goats fed diets containing untreated and biodegraded cassava peels is shown in Table 3. Significant ($P = .05$) differences were obtained for final weight, total weight gain, Weekly weight gain, weekly feed intake and feed conversion ratio. Total weight gained was highest for bucks in T2 (7.0 kg) fed 100% *Pleurotus tuber-regium* biodegraded cassava peels diet, closely followed by T5 (6.10 kg) fed 75% *Pleurotus tuber-regium* biodegraded cassava peels diet, then T4 (5.53 kg) fed 50% *Pleurotus tuber-regium* biodegraded cassava peels diet and T3 (3.75 kg) 25% fed *Pleurotus tuber-regium* biodegraded cassava peels diet; while bucks in T1 gained 1.73 kg.

Weekly feed intake was 1,750, 1,521, 1,503, 1,501 and 1,486 g by bucks in T2, T5, T3, T1 and T4 respectively. The feed conversion ratio recorded was 2.40, 2.75, 4.38, 10.40 and 3.37 in that order.

Cost Benefit Analysis of WAD Bucks Fed Treatment Diets

Table 4 shows the cost benefit of WAD bucks fed the treatment diets in this study. Result of total feed consumed indicated no significant ($P = .05$) difference among treatments. Bucks in T1 consumed a total of 16.60 kg of feed, T2 (16.73 kg), T3 (15.43 kg), T4 (14.80 kg) and T5 (15.55 kg). The cost of these treatment diets however showed significant ($P = .05$) difference. Similarly, cost per kg feed were significant ($P = .05$) for all the treatments.

Table 3: Weight gain of WAD Bucks Fed Treatment Diets

Parameter	T1	T2	T3	T4	T5	SEM
No. of bucks	4	4	4	4	4	-

Feeding period (days)	84	84	84	84	84	-
Initial mean wt (kg)	6.28	6.25	5.57	6.13	5.60	0.15
Final mean wt (kg)	8.00 ^d	13.25 ^a	10.00 ^c	11.50 ^b	11.68 ^b	0.42
Total mean wt gain (kg)	1.73 ^c	7.08 ^a	3.75 ^b	5.53 ^a	6.10 ^a	0.49
Weekly wt gain (g)	152.27 ^d	641.59 ^a	350.00 ^c	506.52 ^b	550.00 ^b	15.82
Total feed intake(g)	16,600	16,730	15,430	14,800	15,550	0.35
Weekly Feed Intake(g)	1501.13 ^b	1749.75 ^a	1503.25 ^b	1485.75 ^b	1520.67 ^b	32.5
Feed conversion ratio (FCR)	10.40 ^a	2.40 ^b	4.38 ^b	3.37 ^b	2.75 ^b	0.78

SEM - Standard error mean

a,b,c,d - Means on the same row with different superscript are significantly (P<0.05) different

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Table 4: Cost Benefit Analysis of WAD Bucks Fed Treatment Diets

Parameter	T1	T2	T3	T4	T5	SEM
Total Feed Consumed (kg)	16.60	16.73	15.43	14.80	15.55	0.35
Cost of Feed Consumed (₦)	766.07 ^{ab}	847.00 ^a	717.57 ^b	692.78 ^b	733.65 ^{ab}	19.03
Cost/ Kg Feed (₦)	46.25 ^e	50.66 ^a	46.50 ^d	46.83 ^c	47.17 ^b	0.37
Benefit/ Kg live Weight gain (₦)*	1,552.58 ^d	6,367.00 ^a	3,375.00 ^c	4,967.50 ^a	5,490.00 ^a	43.87
Benefit Cost Ratio	0.91 ^b	3.38 ^a	2.16 ^a	3.18 ^a	3.35 ^a	0.26

187 a,b,c,d - Means on the same row with different superscript are significantly (P<0.05) different

188 SEM - Standard error mean

189 *₦900.00 per kg weight Chevon (ADP Monthly Technical Review Meeting Report)

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Discussion

Composition of Diets

Crude protein (CP) of T2 was significantly ($P < 0.05$) higher (23.21%) compared to T1 (21.72%) probably because T2 was formulated from PT-CPS which had higher CP (9.83%) relative to UCPS (21.72%) from which T1 was compounded. The CP contents range of treatment diets (21.72 – 23.21%) are above the 17% recommended for growing goats [16]. The extra content of CP could balance for incomplete digestion and imperfect balance of amino acids produced during protein degradation. Furthermore, all diets met the minimum CP (8%) required by microbes for minimum activity [11].

The ether extract contents of the treatment diets varied significantly ($P = .05$) with the highest value of 3.90% for T1 that had 100% UCPS. The lower EE values of other diets containing biodegraded CPS could be a result of increase in EE due to synthesis of fatty acids by microorganisms as suggested by [17].

Crude fibre of the treatment diets are between 9.94 – 10.77%. Though T1 diet is significantly ($P = .05$) higher than other treatment diets, these values are equivalent to more than 67% total digestible nutrients (TDN) for ruminants [18]. . CF is a gross estimate of a feed, so the lower the CF the higher the digestible energy content of the diet. The NFE of the treatment diets varied significantly ($P = .05$), this variation

could be attributed to the influence of graded levels of biodegraded and untreated CPS upon the diets because NFE mixture contain not only starches but some proportion of hemicellulose and lignin [19].

Ash content of the treatment diets showed significantly high value for T5 (6.41%), which differed ($P = .05$) from T2 (6.29%), T3 (6.28%) T1 (6.23%) and T4 (6.17%). The ash contribution from the mycelia biomass of the fungus during biodegradation could be the reason for these differences as observed by some workers [7, 20]. However, the Ca and P contents of all the diets are within the range: Ca (0.3– 0.8%) and P (0.025 – 0.4%) of what is recommended for growing goats [16, 21].

NDF values of treatment diets showed decrease with increasing amount of biodegraded CPS (T1, 38.87; T2, 36.56; T3, 38.27; T4, 437.93 and T5, 36.74%). This trend could be ascribed to the increase in neutral detergent solubles of the biodegraded CPS portion of the treatment diets. In order to maintain optimal roughage digestion, ruminant diet should contain a minimum of 20% NDF on a dry matter basis [22].

The metabolisable energy (ME) values of the treatment diets showed no significance ($P = .05$). The ME of the diets are within the recommended levels (6 - 13MJ/kg DM) for maintenance and production for goats [22] except for the control diet (T1) containing UCPS.

Weight gain of WAD Bucks Fed Treatment Diets

Weight gain of WAD bucks fed the treatment diets shows bucks on 100% PT-CPS diet (T2) with significantly ($P = .05$) the highest final mean weight of 13.25kg while bucks on UCPS diet (T1) had the lowest final mean weight of 8.00kg. This performance may be attributed to the better elements, compounds, nutrient digestibility and availability to the bucks in the order of treatment T2>T5>T4>T3>T1. Though, the diets CP were all above the minimum requirement of 8%CP; to provide the nitrogen levels required by rumen microbes for optimum activity [11], T2 bucks showed superior final weight.

A corresponding significant ($P = .05$) total weight gain was recorded for T2 (7.08kg) followed closely by bucks on 75% PT-CPS, T5 (6.10kg), 50%PT-CPS, T4 (5.53kg), 25%PT-CPS, T3 (3.75) while the lowest was by bucks on control diet, T1 (1.73kg). It is imperative that nutritive value of feed expresses itself not only by chemical assay but by evidence of improved gain [23].

Weekly weight gain was observed to be significantly ($P < 0.05$) highest (641.59g/wk) for bucks in T2 and least (152.27g/wk) for bucks in T1. This weekly gain could also be attributed to the significantly ($P < 0.05$) highest weekly feed intake (1,749.75g) recorded by bucks in the same 100% PT-CPS diet, T2 and, the lowest weekly feed intake (1,501.13g) recorded by bucks UCPS diet, T1. The trend of the result in this study could be an indication of better acceptability, protein contribution and nutrient utilisation of the 100% PT-CPS diet of T2. Feed intake has been observed to be governed by dietary crude protein, palatability and other factors like gut fill in WAD goats fed cassava peel based diets [4, 24].

Significant ($P = .05$) feed conversion ratios of 2.40, 2.75, 3.37, 4.38 and 10.40 recorded for bucks in T2, T5, T4, T3 and T1 respectively agrees with the trend reported by some workers [24, 25] that increased microbial degradation could be the reason for improved intakes, weight gains and better feed conversion ratios. These workers had achieved similar results in performance indices with supplementation or treatment of cassava peels to improve the crude protein and fibre contents for better utilisation by WAD goats because cassava peel cannot support optimum rumen function and productivity because it's poor in crude protein and fibre [26].

Cost Benefit Analysis of WAD Bucks Fed Treatment Diets

Cost of feed consumed was significantly ($P = .05$) highest for T2 because more feed were consumed (16.73 kg) and the cost per kg feed was significantly ($P < 0.05$) the highest (N50.66). Benefit per kg live weight showed significance ($P = .05$) among treatments, T2 (N6, 367.00), T5 (N5, 490.00), T4 (N4,967.50), T3 (N3, 375.00) and T1 (N1, 552.58). The highest benefit of N6, 367.00 recorded for T2 though gave highest cost per kg feed (N50.66) as the bucks in T2 also recorded best ($P < 0.05$) total weight gain of 7.08 kg in comparison to 6.10, 5.53, 3.75, and 1.73 kg gain by bucks in T5, T4, T3 and T1 respectively. Similar result was obtained for WAD goats fed chemically treated cassava peels [11]. The benefit cost ratio (BCR) shows no significant ($P > 0.05$) difference among T2 (3.38), T3 (2.16), T4 (3.18), T5 (3.35) but is significantly ($P = .05$) different from T1 (0.91). But BCR of T1 diet is less than one so, not worth adopting as a diet for growing WAD goats [13]. Feeding diet T2 to growing WAD goats could be more beneficial.

Conclusion

Weight gain of WAD bucks fed the treatment diets showed bucks fed 100% PT-CPS treatment diet (T2) had the highest final mean weight of 13.25 kg, total weight gain of 7.08kg, weekly weight gain of 641.59 g, weekly feed intake of 1,749.75 g and superior feed conversion efficiency of 2.40. Cost benefit analysis recorded the least BCR of 0.91 for 100% UCPS diet (T1) while the best BCR of 3.38 was recorded for 100% PT-CPS treatment diet (T2). It was concluded that incorporation of 100% of cassava peels (45% of the diet) biodegraded by *Pleurotus tuber-regium* for 21 days had potential economic gain in growing West African Dwarf goats.

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