

Original Research Article

Performance of West African Dwarf (WAD) Goats Fed *Pleurotus tuber-regium* biodegraded Cassava (*manihot esculenta*) peels based diets

Abstract

Twenty intact WAD bucks of age between 7-9 months and weighing on the average $6.17 \pm 0.96\text{kg}$ were randomly allocated to five treatment diets containing untreated cassava peels (UCPS) and *Pleurotus tuber-regium* biodegraded cassava peels (PT-CPS) based diets in a completely randomized designed experiment lasting 84 days to evaluate daily feed intake, weekly weight gain, feed conversion ratio, benefit, cost and cost benefit ratio. Growth performance of WAD bucks fed treatment diets showed significant ($P < 0.05$) final weight of 13.25kg by bucks fed 100% PT-CPS diet (T2), and the lowest 8.00kg for 100%UCPS. Bucks on T2 diets also recorded the highest ($P < 0.05$) total mean weight gain of 7.08kg while bucks on control T1 diet had 1.73kg as total mean weight gain. Weekly feed intake by the bucks were equally highest ($P < 0.05$) for bucks in T2 ($1,749.75\text{g}$) and lowest for bucks in T1 ($1,501.13\text{g}$). Cost per kg feed consumed recorded a significant ($P < 0.05$) ₦ 50.66 for 100% PT-CPS diet. Benefit cost ratio (BCR) from the benefit cost analysis showed a superior ($P < 0.05$) 3.38 for bucks fed 100% PT-CPS diet (T2) and lowest BCR of less than 1 value of 0.91 obtained for bucks fed 100% UCPS diet (T1); inferring treatment T1 is not worth adopting. This study shows the superiority of 100% biodegraded cassava peel inclusion in the diets of WAD goats and potential economic gain.

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

23 Introduction

24 Cassava (*Manihot esculenta*. Crantz) is a root crop with underground storage tuber widely
 25 cultivated in the tropics and is one of the most important staple food crops grown in tropical
 26 Africa. Nigeria is the world leading producer of cassava, with projected annual production of 60
 27 million tonnes (FAO, 2009). Cassava peels make up 10% of the total wet weight and could be 20
 28 -35% of the wet weight if the tubers are hand peeled manually (Oboh, 2006 and Obadina *et al.*,
 29 2006).

30 Feed intake has been observed to be governed by dietary crude protein, palatability and other
 31 factors like gut fill, body fat and changes in the body chemical constituents (Ahamefule, 2005;
 32 Ukanwoko, 2007). The importance of protein intake as the determinant of performance in
 33 ruminants has been strongly emphasized (Preston and Leng, 1987). Inverse relationship exist
 34 between dry matter intake and fibre content of feeds that tends to suggest decrease level of CF
 35 content increases palatability (Ukanwoko *et al.*, 2009).

36 Cassava peels are lignocellulosic in nature, possessing the components cellulose, hemicelluloses
 37 and lignin. Lignin, a heterogeneous polymer structure of the vascular plants is the most abundant
 38 renewable material next to cellulose (Ohkuma *et al.*, 2001). Lignin plays a key role in the carbon
 39 cycle as the most abundant aromatic compound in nature, providing the protective matrix
 40 surrounding the cellulose micro fibrils of plant cell walls (Mshandete and Mgonja, 2009). This
 41 phenylpropanoid polymer resists chemical or enzymatic degradation to protect cellulose (the
 42 most abundant of all naturally occurring organic compounds). For cassava peels to make
 43 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 (Obboh, 2006).

Many workers (Ohkuma *et al.*, 2001; Shah and Nerud, 2002; Mshandete and Mgonja, 2009) 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 into livestock feeding. This process will invariably reduce the cost of ruminant production.

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

67 **Materials and Methods**

68 **Experimental Site**

69 The study was conducted at the Farm Unit of the College of Agriculture, Lafia, Nigeria located
70 Latitude N08⁰ 29'8.66"; Longitude E08⁰ 29' 49.10"and Altitude 164.5m; in the guinea savannah
71 vegetation, with its sandy loam soil texture (Akwa *et al.*, 2007).

72 **Treatment of Cassava Peel**

73 Fresh cassava peel was obtained from the Family Support Programme's Gari Processing
74 Industry, Shabu – Lafia and sun dried for six days as describe by Uza *et al.* (2005). Treatment of
75 cassava peels (with *pleurotus tuber- regium*) was by inoculation of composted cassava peels
76 with slides of the tuber on a concrete floor at room temperature covered with polythene sheet and
77 allowed to ferment for 21 days.

78 **Proximate composition**

79 DM was determined by oven drying the milled samples to a constant weight at 105⁰C for 8
80 hours. Crude protein was determined as Kjeldhal nitrogen x 6.25. Ether extracts, crude fibre and
81 ash were determined according to (AOAC, 2005) method.

82 **Experimental Diets**

83 Five diets containing untreated and biodegraded cassava peels were compounded as follows:

84 T1 – 100% untreated cassava peels (UCPS)

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

86 T3 – 75% UCPS + 25% PT-CPS

87 T4 – 50% UCPS + 50% PT-CPS

88 T5 – 25% UCPS + 75% PT-CPS

89 **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

90 *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
 91 B2 5,500mg; Vit B6 1,200 mg; Vit B12 12 mg; Biotin 30 mg; Folic Acid 600 mg; Niacin 10,000 mg; Pantothenic
 92 Acid 7,000mg; Choline chloride 500,000 mg; Vit C 10,000mg; Iron 60,000 mg; Mn 80,000 mg; Cu 8,00mg; Zn
 93 50,000 mg; Iodine 2,000 mg; Cobalt 450 mg; Selenium 100 mg; Mg 100,000 mg; Anti Oxidant 6,000 mg.

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

97 **Animal Management**

98 Twenty West African Dwarf (WAD) intact bucks of age between 7-9 months and having an
 99 average weight of 6.17 ± 0.96 kg from the small ruminant section of the farm were allocated to
 100 five treatments (T1, T2, T3, T4 and T5) diets in a completely randomized design format (Steel
 101 and Torrie, 1980). The bucks were housed in individual pens measuring 1.5m^2 each with feed
 102 and watering troughs. The animals, four per treatment were allowed access to water, mineral salt
 103 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 (Dixon *et al.*, 1989). 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 1. Significant ($P<0.05$) proximate components values were obtained for treatments diet; CP% is significantly ($P<0.05$) better 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 are not significantly ($P>0.05$) different.

Fibre fraction components of the treatment diets were all significantly ($P < 0.05$) different. NDF % is 38.87, 36.56, 38.27, and 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 decrease 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/kgDM for T1, T2, T3, T4 and T5 respectively, no significant ($P > 0.05$) differences was observed for ME values

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TABLE 1: CHEMICAL COMPOSITION OF TREATMENT DIETS

%	T1	T2	T3	T4	T5	SEM
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 ^c	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	0.53	0.50	0.46	0.48	0.12
NDF	38.87a	36.56e	38.27b	37.93c	36.74d	0.32
ADF	21.71a	17.31e	19.03b	18.80c	17.60d	0.42
ADL	5.30a	4.70d	5.27b	5.15c	4.69d	0.09
Hemicellulose	18.16d	19.25a	19.20b	19.13c	19.14c	0.11
Cellulose	16.41a	12.81e	13.81b	13.65c	12.90d	0.35
ME (MJ/KgDM)	5.87	7.90	6.52	6.96	7.14	0.19

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

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CP –Crude Protein.

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EE –Ether Extract

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CF –Crude Fibre

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NDF – Neutral Detergent Fibre

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ADF – Acid Detergent Fibre

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ADL – Acid Detergent Lignin

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SEM – Standard Error of Mean

Performance of WAD Bucks Fed Treatment Diets

Performance parameters of WAD goats fed diets containing untreated and biodegraded cassava peels is shown in Table 2. Significant ($P<0.05$) 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 (7.0kg) fed 100% *Pleurotus tuber-regium* biodegraded cassava peels diet, closely followed by T5 (6.10kg) fed 75% *Pleurotus tuber-regium* biodegraded cassava peels diet, then T4 (5.53kg) fed 50% *Pleurotus tuber-regium* biodegraded cassava peels diet and T3 (3.75kg) 25% fed *Pleurotus tuber-regium* biodegraded cassava peels diet; while bucks in T1 gained 1.73kg.

Weekly feed intake was 1,750, 1,521, 1,503 1,501 and 1,486g 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 3 shows the cost benefit of WAD bucks fed the treatment diets in this study. Result of total feed consumed indicated no significant ($P>0.05$) difference among treatments. Bucks in T1 consumed a total of 16.60kg of feed, T2 (16.73kg), T3 (15.43kg), T4 (14.80kg) and T5 (15.55kg). The cost of these treatment diets however showed significant ($P<0.05$) difference. Similarly, cost per kg feed were significant ($P<0.05$) for all the treatments: T1, 46.25N; T2, 50.66N; T3, 45.50N; T4, 46.83N and T5, 47.17N.

177 **TABLE 2: PERFORMANCE 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

178 SEM - Standard error mean

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

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185 **TABLE 3: COST BENEFIT ANALYSIS OF WAD BUCKS FED TREATMENT DIETS**

Parameter	T1	T2	T3	T4	T5	SEM
Total Feed Consumed	16.60	16.73	15.43	14.80	15.55	0.35
(kg)						
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 ^c	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

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

187 SEM - Standard error mean

188 *₦900.00 per kg weight Chevron (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 (3.33%) from which T1 was compounded. The CP contents range of treatment diets (21.72 – 23. 21%) are above the 17% recommended for growing goats (Rashid, 2008). 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 optimum activity (Uza *et al.*, 2005).

The ether extract contents of the treatment diets varied significantly ($P<0.05$) 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 Salman *et al.* (2011).

Crude fibre of the treatment diets are between 9.94 – 10.77%. Though T1 diet is significantly ($P<0.05$) higher than other treatment diets, these values are equivalent to more than 67% total digestible nutrients (TDN) for ruminants (Machen, 2012). 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 ($P<0.05$), 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 (Khan *et al.*, 2003).

Ash content of the treatment diets showed significantly high value for T5 (6.41%), which differed ($P<0.05$) 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 difference as observed by some workers (Mshandete and Mgonja, 2007; Mallikajima *et al.*, 2013). 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 (Gimerenez, 2004; Rashid, 2008).

NDF values of treatment diets showed decrease with increasing amount of biodegraded CPS (T1, 38.87; T2, 36.56; T3, 38.27; T4, 37.93 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 (David, 2012).

The metabolisable energy (ME) values of the treatment diets showed no significance ($P>0.05$) The ME values recorded are 7.90, 7.14, 6.96, 6.52 and 5.87 MJ/kgDM respectively. The ME of the diets are within the recommended levels (6 - 13MJ/kgDM) for maintenance and production for goats (Steele, 2006) except for the control diet (T1) containing UCPS.

Performance of WAD Bucks Fed Treatment Diets

Performance of WAD bucks fed the treatment diets shows bucks on 100%PT-CPS diet (T2) with significantly ($P<0.05$) 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 (Uza *et al.*, 2005), T2 bucks showed superior final weight.

244 A corresponding significant ($P<0.05$) total weight gain was recorded for T2 (7.08kg) followed
 245 closely by bucks on 75% PT-CPS, T5 (6.10kg), 50%PT-CPS, T4 (5.53kg), 25%PT-CPS,T3
 246 (3.75) while the lowest was by bucks on control diet, T1 (1.73kg). It is imperative that nutritive
 247 value of feed expresses itself not only by chemical assay but by evidence of improved gain
 248 (David, 2012).

249 Weekly weight gain was observed to be significantly ($P<0.05$) highest (641.59g/wk) for bucks in
 250 T2 and least (152.27g/wk) for bucks in T1. This weekly gain could also be attributed to the
 251 significantly ($P<0.05$) highest weekly feed intake (1,749.75g) recorded by bucks in the same
 252 100% PT-CPS diet, T2 and, the lowest weekly feed intake (1,501.13g) recorded by bucks UCPS
 253 diet, T1. The trend of the result in this study could be an indication of better acceptability,
 254 protein contribution and nutrient utilisation of the 100% PT-CPS diet of T2. Feed intake has
 255 been observed to be governed by dietary crude protein, palatability and other factors like gut fill
 256 in WAD goats fed cassava peel based diets (Ukanwoko *et al.*, 2009; Ukanwoko and Onuoha,
 257 2011).

258 Significant ($P<0.05$) feed conversion ratios of 2.40, 2.75, 3.37, 4.38 and 10.40 recorded for
 259 bucks in T2, T5, T4, T3 and T1 respectively agrees with the trend reported by some workers
 260 (Uza *et al.*, 2005; Barde *et al.*, 2010; Ukanwoko and Onuoha, 2011; Asaolu *et al.*, 2012) that
 261 increased microbial degradation could be the reason for improved intakes, weight gains and
 262 better feed conversion ratios. These workers had achieved similar results in performance indices
 263 with supplementation or treatment of cassava peels to improve the crude protein and fibre
 264 contents for better utilisation by WAD goats because cassava peel cannot support optimum
 265 rumen function and productivity because if it's poor crude protein and fibre (Smith, 1989),

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Cost Benefit Analysis of WAD Bucks fed Treatment Diets

Cost of feed consumed was significantly ($P<0.05$) highest for T2 because more feed were consumed (16.73kg) and the cost per kg feed was significantly ($P<0.05$) the highest (N50.66). Benefit per kg live weight showed significance ($P<0.05$) 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 the highest cost per kg feed (N50.66) as the bucks in T2 also recorded best ($P<0.05$) total weight gain of 7.08kg 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 (Uza *et al.*, 2005). 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 ($P<0.05$) different from T1's 0.91. But BCR of T1 diet is less than one so, not worth adopting as a diet for growing WAD goats (Dixon *et al.*, 1989). Feeding diet T2 to growing WAD goats could be more beneficial.

Conclusion

Performance of WAD bucks fed the treatment diets showed bucks fed 100%PT-CPS treatment diet (T2) had the highest final mean weight of 13.25kg, total weight gain of 7.08kg, weekly weight gain of 641.59g, weekly feed intake of 1,749.75g and superior feed conversion efficiency of 2.40. Cost benefit analysis recorded the least as 0.91 BCR for 100% UCPS diet (T1) while the best BCR of 3.38 was recorded for 100%PT-CPS treatment diet (T2). This could conclude the superiority of 100% biodegraded cassava peel inclusion in the diets of WAD goats and potential economic gain.

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