Animal and Veterinary Sciences
2016; 4(3-1): 7-12
http://www.sciencepublishinggroup.com/j/avs
doi: 10.11648/j.avs.s.2016040301.12
ISSN: 2328-5842 (Print); ISSN: 2328-5850 (Online)

Effects of Feeding Sun-Dried Yellow Cashew Pulp Based Diets on Performance, Dry Matter and Nutrient Digestibility of West African Dwarf Goats

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To cite this article:

Okpanachi U., OyewoleB. O., Egbu, C. F., Ganiyu, O. Y. Effects of Feeding Sun-Dried Yellow Cashew Pulp Based Diets on Performance, Dry Matter and Nutrient Digestibility of West African Dwarf Goats. *Animal and Veterinary Sciences.* Special Issue: Issue I: Foundations of Hadronic Mathematics. Vol. 4, No. 3-1, 2016, pp. 7-12. doi: 10.11648/j.avs.s.2016040301.12

Received: January 19, 2016; **Accepted:** January 19, 2016; **Published:** June 4, 2016

Abstract: A study was conducted to study the effects of feeding sun-dried cashew pulp based diets on performance, dry matter and nutrient digestibility of West African dwarf goats. Twenty growing goats of about 6-7 months, having an average initial weight of 6.42kg were randomly assigned to the treatments; each treatment had five experimental units. Four diets containing 0 (control), 10, 20 and 30% dried yellow cashew pulp coded as T_1, T_2, T_3 and T_4, respectively, were compared. Completely randomized design was used in all the experiments. Data obtained were subjected to Analysis of Variance (ANOVA) and means that were significantly different were separated using Least Significant Difference (LSD). None of the performance parameter was significantly affected ($P > 0.05$) by the inclusion of sun-dried cashew pulp meal. However, crude fibre and ether extract were significantly affected ($P < 0.05$) by the inclusion of sun-dried yellow cashew pulp. This study indicated that sun-dried cashew pulp can be fed to WAD goats up to 30% level of inclusion in diets without an adverse effect on them. Inclusion of cashew pulp sun-dried to the tone of 30% will also provide a cheaper source of feed and also help to reduce environmental pollution since the study area is known to be the highest cashew producing state in Nigeria and the pulp unlike the seed are left to waste during its season. The use of cashew pulp in livestock diet is therefore advocated.

Keywords: Yellow Cashew Pulp, Nutrient Digestibility, Dry Matter, West African Dwarf Goats

1. Introduction

Low agricultural productivity in Nigeria results in feed scarcity, which further accelerates the competition between man and livestock for the conventional energy and protein feed stuffs. There is a strong quest to find plausible solution to the twin problems of low agricultural productivity and competition for foodstuff which necessitates exploring biological attributes of goats in the use of agricultural wastes. Feed accounts for the dominant input in animal production ranging from 60-70% of the total cost of production (Ranjhan, 2001). One of the major reasons for the low level of animal protein intake in the tropics and in Nigeria in particular is because livestock production is not keeping pace with human population growth rate put at 3.2% (National Planning Commission, 2006). Adeniji and Balogun (2002) suggested that a solution to this problem of poor consumption of animal protein by an average Nigerian is to increase the level of production of highly productive animals with short generation interval, such as poultry, pigs, rabbits, sheep and goats.

Goats supply precious proteins of high biological value in the form of milk, and meat. The 2001 population of livestock in Nigeria has been estimated to be 45.26 m goats, 118.59 m poultry, 28.69 m sheep, 15.60 m cattle, 5.25 m pigs and 1 m horses, camels and donkeys (NPC, 2004). This is against an estimation of 34.5 million goats, 170 million poultry, 22.1 million sheep, 14 million cattle and 3.4 million pigs (RIM, 1992). In Nigeria, goats and sheep contribute about 30% of the total meat consumption (Odeyinka, 2000). The goats in

Nigeria represent an important source of meat and the demand for goat meat is very high especially in rural areas where it often commands higher market price than beef (Odeyinka, 2000). Nevertheless, goat production is severely limited by inadequate nutrition especially during the dry season where there is a decline in the yield and quality of forages (Odeyinka, 2000).

Cashew apple waste contents of crude protein (CP), CF, ether extract (EE) and ash were 187 (18.7%), 84, 24 and 54 g/kg DM, respectively as reported by Fanimo *et al.* (2003). The crude protein, fat, ash, crude fibre in g/kg DM and digestible energy contents reported by Armah (2011) for dry cashew pulp (DCP) were 86.0 g/kg, 99.6 g/kg, 38.0 g/kg, 116.0 g/kg and 14.38 MJ, respectively.

In this research work by Fanimo *et al.* (2003), rabbits fed diets with 20 and 30% cashew apple waste (CAW) gained weight faster ($P < 0.05$) than rabbits fed diets without CAW. Apparent digestibility of CF decreased ($P < 0.05$) with increase in the level of CAW in the diets. Cholesterol level increased ($P < 0.05$) with CAW inclusion in diets. Generally, CAW increased ($P < 0.05$) the relative weight of the carcass traits. They concluded that dried cashew apple waste is a good feed resource for rabbits and can be included in such diets up to 30% without a significant adverse effect on performance, protein digestibility and carcass quality. According to Armah (2011), the level of DCP had no significant ($P > 0.05$) effect on feed intake but had a significant ($P < 0.05$) effect on weight gain of pigs. Final live weights were 58.67, 53.0, 59.67 and 48.67 kg for pig's diets containing 0, 50, 100 and 150 DCP g/kg, respectively. There were neither health-related problems nor deaths that could be attributed to the inclusion of DCP in the diet. Feed cost per diet decreased with increasing DCP levels. The cost of feed to produce a kg weight gain was lowest for the diet containing the 100 g DCP kg^{-1}. It was concluded that up to 100 g DCP kg^{-1} diet had a positive effect on pig growth performance and that partial replacement of energy sources such as maize and wheat bran with DCP is possible.

To solve this problem of feed inadequacy, one possible source of cheap feed material to be used is cashew pulp meal (CPM), which is mostly left to constitute environmental pollution during its season. This is because most people prefer the seed to the cashew pulp. The inclusion of this alternative feedstuff in animal diets might be interesting in some circumstances (relative price, feed quality, etc), but it is limited because of the inadequate information on the nutritive value of cashew pulp. According to personal interview with the staff of Cocoa Research Institute of Nigeria (who has cashew as one of their mandate crops), Kogi state where the study area (Anyigba in Dekina LGA) is located is the highest cashew producing state in Nigeria.

2. Materials and Methods

2.1. Procurement and Preparation of Cashew Pulp

Yellow cashew apple pulp was obtained from Anyigba and its environs. Anyigba is in Kogi State, Nigeria. They were washed, sliced with the aid of knives and chopping boards into bits, air-dried and moved to the glass house where they were properly dried. The dried cashew pulp were packaged, weighed and stored in a safe place. The dried cashew pulp was later milled and sent to the laboratories for analysis.

2.2. Proximate Composition Analysis

Samples of the yellow cashew pulp were dried, milled and analysed for crude protein (CP), crude fibre (CF), ether extract (EE) and ash according to AOAC (1990). All the proximate values were reported in percentages (Okwu and Morah, 2004).

2.3. Data Collection and Statistical Analysis

Data on performance, dry matter and nutrient digestibility of WAD goats fed sun-dried yellow cashew pulp were collected and subjected to a one way analysis of variance (ANOVA) using SPSS, 16.0 Evaluation Version for windows in a Complete Randomized Design (CRD). Significant mean levels were separated using Least Significant Difference.

Table 1. *Gross Composition of Experimental Diets Fed to West African Dwarf Goats.*

Experimental Diets				
Ingredients (%)	**T_1 (0%)**	**T_2 (10%)**	**T_3 (20%)**	**T_4 (30%)**
Cashew Pulp	0.00	10.00	20.00	30.00
Bambaranut Waste	28.80	18.00	13.50	8.00
Maize Offal	19.20	18.00	11.00	4.00
Rice Offal	3.00	3.00	4.50	6.00
Burukutu Waste	37.00	39.00	39.00	40.00
Oil Palm Sludge	6.00	6.00	6.00	6.00
Cassava Peel	3.00	3.00	3.00	3.00
Bone Meal	2.00	2.00	2.00	2.00
Salt	1.00	1.00	1.00	1.00
Total	100	100	100	100
Calculated values				
Crude Protein (%)	17.26	17.17	17.10	17.10
Crude Fibre (%)	16.76	16.11	16.06	16.05
ME (Kcal/Kg)	2513.91	2540.40	2575.49	2603.25

M E = Metabolisable Energy.

3. Results

3.1. Proximate Analysis of the Experimental Diets

Table 2. *Proximate Analysis of the Experimental Diets.*

Treatments					
Components (%)	**T_1 (0%)**	**T_2 (10%)**	**T_3 (20%)**	**T_4 (30%)**	**SEM**
Dry matter	90.71^{b}	91.18^{c}	91.80^{a}	0.43^{**}	88.07^{d}
Ether extract	10.21^{c}	10.18^{c}	11.47^{b}	0.25^{**}	12.11^{a}
Crude fibre	24.76^{d}	26.30^{a}	25.81^{c}	0.18^{**}	26.09^{b}
Crude protein	14.82^{c}	15.82^{b}	16.92^{a}	0.26^{**}	16.92^{a}

a, b, c, d = Means with different superscripts on the same row are significantly different ($P < 0.01$) SEM = Standard Error of Mean, ** = Significant at ($P < 0.01$)

The proximate composition of the experimental diets is

presented in Table 2. Result on dry matter showed that T_3 was significantly higher than for other treatments. For ether extract, T_4 was significantly higher than for other treatments. In the case of crude fibre, T_2 was significantly higher than for other treatments, while for crude protein, T_3 and T_4 were significantly higher than for other treatments. Values for dry matter ranged from 88.07% (T_4) - 91.80% (T_3); ether extract ranged from 10.18% (T_2) - 12. 11% (T_4); crude fibre 24.76% (T_1) – 26.30% (T_2) and crude protein ranged from 14.82% (T_1) – 16.92% (T_3 and T_4).

3.2. Effect of Feeding Sun-Dried Cashew Pulp Based Diets on Performance of Experimental Goats

The effect of feeding sun-dried cashew pulp based diet on performance is presented in Table 3. None of the performance parameters were significantly affected ($P > 0.05$) by the inclusion of sun-dried cashew pulp meal. The average final body weight was from 6712 g (T_3) – 7708 g (T_1). Average daily and total feed intakes ranged from 237.52 (T_2) – 259.45 (T_1) and 21614.00 (T_2) – 23610.00 (T_1) respectively. Average daily and total water intakes ranged from 330.95 (T_3) – 386.07 (T_1) and 25483.00 (T_3) - 29726.00 (T_1) respectively. Average daily body weight gain and total body weight gains ranged from 3.43 (T_3) - 12.83 (T_1) and 312.00 (T_3) - 1168.00 (T_1) respectively. FCR ranged from 20.22 (T_1) – 70.16 (T_3). None of the performance parameters were significantly affected ($P > 0.05$) by the inclusion of sun-dried cashew pulp meal.

Slight decrease was observed for most of the treatments, with goats in T_3 having the major decrease in body weight gain. The general decrease in body weight gain may be due to the health challenges faced by the goats due to season, with those in T_3 having the worst hit. The various ailments generally faced by the experimental goats were treated. It is however possible that the goats in this treatment did not fight the ailments like others did (the place of individual difference). The season (raining season) which encourages many of their diseases might have also contributed to this weight lost. Total confinement throughout the period of the study might have also prevented the experimental goats from performing maximally since goats (especially WAD goats) are known not to thrive well under complete confinement.

Table 3. *Effect of Feeding Sun-dried Cashew Pulp Based Diets on Performance of Experimental Goats.*

Experimental Diets					
Parameters	**T_1 (0%)**	**T_2 (10%)**	**T_3 (20%)**	**T_4 (30%)**	**SEM**
Average Initial B W (g)	6540.00	6340.00	6400.00	6380.00	0.15^{ns}
Average Final B W (g)	7708.00	6912.00	6712.00	7110.00	0.36^{ns}
Average Daily Feed Intake (g)	259.45	237.52	240.66	245.88	9.37^{ns}
Average Total Feed Intake (g)	21614.00	23610.00	22375.0	21900.00	852.67^{ns}
Average Daily Water Intake (ml)	386.07	372.72	330.95	363.25	17.25^{ns}
Average Total Water Intake (ml)	28700.00	29726.00	25483.00	27970.00	1328.20^{ns}
Average Daily B W Gain (g)	12.83	6.29	3.43	8.02	3.74^{ns}
Total B W Gain (g)	1168.00	572.00	312.00	730.00	339.97^{ns}
F C R	20.22	37.76	70.16	30.66	8.12^{ns}

SEM = Standard Error of Mean, ns = not significant, B W = Body Weight, FCR = Feed Conversion Ratio.

3.3. Dry Matter and Nutrient Digestibility of West African Dwarf Goats Fed Sun-Dried Cashew Pulp-Based Diets

The result of dry matter and nutrient digestibility of West African Dwarf Goats fed diets containing sun-dried cashew pulp based meal is presented in Table 4. Crude fibre and ether extract were significantly affected ($P < 0.05$) by the level of inclusion of sun-dried cashew pulp. Dry matter and crude protein values were not significantly affected ($P > 0.05$). Values for dry matter ranged from 91.14 (T_4) – 95.44 (T_1); crude protein from 48.52 (T_4) – 54.99 (T_1); crude fibre ranged from 52.32 (T_3) – 61.77 (T_1) and ether extract ranged from 66.64 (T_2) – 73.20 (T_1).

Table 4. *Dry Matter and Nutrient Digestibility of West African Dwarf Goats Fed Diets Containing Sun-dried Cashew Pulp- Based Diets.*

Experimental Diets					
Nutrients (%)	**T_1 (0%)**	**T_2 (10%)**	**T_3 (20%)**	**T_4 (30%)**	**SEM**
Dry Matter	95.44	94.49	94.67	91.14	0.68^{ns}
Crude Protein	54.99	50.62	52.20	48.52	2.46^{ns}
Crude Fibre	61.77^{a}	61.35^{a}	52.32^{c}	58.35^{ab}	1.40^{*}
Ether Extract	73.20^{a}	66.64^{b}	67.24^{b}	72.38^{a}	1.07^{*}

a, b, c = Means with different superscripts on the same row are significantly different ($P < 0.05$)
SEM = Standard Error of Mean, ns = not significant, * = Significant at ($P < 0.05$)

4. Discussion

4.1. Proximate Composition of the Experimental Diets

The range for dry matter (88.07% - 91.80%) in the experimental diets used in this study was higher than 88.67% - 89.97% and 83.45% - 84.61% reported by Oloche *et al*. (2013a) and Oduguwa *et al.* (2012) respectively. The value for ether extract in T_4 was statistically higher ($P < 0.01$) than for other treatments. Ether extracts (10.18% - 12. 11%) obtained for diets in this study is higher than 6.02% - 9.55%, 6.79% - 7.25% and 2.64% - 11.37% reported by Oloche *et al*. (2013a), Oloche *et al*. (2013b) and Oduguwa *et al.* (2012) respectively for diets fed to WAD goats. The value for crude fibre in T_2 was statistically higher ($P < 0.01$) than for other treatments. Crude fibre of 24.76% – 26.30% obtained in this study is higher than 11.05% - 14.22%, 14.13% - 14.37% and 5.45% - 8.02% reported by Oloche *et al*. (2013a), Oloche *et*

al. (2013b) and Oduguwa *et al.* (2012) respectively for diets fed to WAD goats. The high crude fibre of the experimental diets could not have been due to the inclusion of sun-dried cashew pulp since result of proximate analysis showed that sun-dried cashew pulp has a crude fibre of 6.71% - 7.08%. The values for crude protein in T_3 and T_4 were higher than for other treatments. The crude protein of 14.82% – 16.92% obtained in this study is higher than 14.72% - 16.41%, 16.04% - 16.16% and 5.16% - 12.69% reported by Oloche *et al*. (2013a), Oloche *et al*. (2013b) and Oduguwa *et al.* (2012) respectively. However, the crude protein range of 14.82% - 16.92% obtained in this study are adequate for maintenance and growth of small ruminants (NRC, 1996) and it exceeds the 8% that can provide minimum ammonium level required for microbial activity (Norton, 1994). The variations in the proximate analysis of the experimental diets for WAD goats reported by various authors may have been due to the different feedstuffs used in compounding the feeds in these studies.

4.2. Effect of Feeding Sun-Dried Cashew Pulp Based Diets on Performance of Experimental Goats

The none difference in the performance parameter of goats fed the experimental treatments agrees with the study by Oloche *et al*. (2013a). The range of 6712 g – 7708 g for average final body weight in this study is lower than 8050 g – 10500 g reported by Kalio *et al*. (2013) who fed crop by-products (peels of yam, cassava, sweet potato and ripe plantain) to West African Dwarf (WAD) bucks. The range of 7.38 kg - 8.85 kg as average final body weight reported by Oloche *et al*. (2013a) who fed sweet orange peel meal-based diets to WAD goats is slightly higher than that in this study. These variations in final body weights of goats could be as a result of several factors such as the initial weights of the goats in the various studies carried out by the authors cited. The difference in the nature of feed offered could also be responsible for these variations. For instance, the feed used in this study, unlike most of the studies cited is devoid of conventional feedstuffs. The nature of the mixture of the agro-waste materials used in compounding the experimental diets in this study might have brought about the very high crude fibre range of 24.76% - 26.30%, leading to low feed intake and a resultant decrease in weight gain, since high fibre content of the diet might have brought about the dilution of other nutrients. These might have also resulted to inefficient digestion in the rumen and inefficient utilization of the nutrients absorbed from the feed. The low digestibility of the feed (especially that of crude protein) as observed from Table 4 further explains this. The range of 237.52 g – 259.45 g, as average daily feed intake in this study is lower than 525.14 g – 546.26 g and 537.77 g – 561. 37 g reported by Oloche *et al*. (2013a) and Oloche *et al*. (2013b). Oloche *et al*. (2013a) fed shea butter leaves supplemented with varying levels of sweet orange peel meal to WAD goats. The daily feed intake of 407.6 g – 658.7 g reported by Oduguwa *et al.* (2012) who fed WAD goats varying levels of pineapple and cassava peel wastes basal diet is also higher than that obtained in this study. Average daily water intakes (330.95 mL – 386.07 mL) in this study are lower than 727.09 mL – 764.65 mL reported for WAD goats by Oloche *et al*. (2013a). Average daily body weight gain (3.43 g - 12.83 g) in this study is lower than 6.85 g – 24.70 g reported for WAD goats by Oloche *et al*. (2013a) and 47.62 g – 68.65 g (Oloche *et al*., 2013b). Also, average daily body weight gains of 8.33 g – 35.56 g and 12.5 g – 33.9 for WAD goats reported by Kalio *et al*. (2013) and Oduguwa *et al.* (2012) respectively are higher than that in this study. Moemeka *et al.* (2013) however reported an average daily body weight gain (weight loss) of -1.55 g – 3.93 g which is far lower than that reported in this study. Feed conversion ratio (FCR) in this study ranged from 20.22 – 70.16. Kalio *et al*. (2013) reported a FCR of 5.87 – 12.86. Feed conversion ratios of 8.17 – 11.31 were reported by Oloche *et al*. (2013b). Similarly, the values of FCR in this study are higher than those of Kalio *et al.* (2013) and Oloche *et al*. (2013b). The very high FCR (70.16) obtained for T_3 in this study is as a result of a decrease in body weight gain of the experimental WAD goats. As earlier stated, slight decrease was observed for most of the treatments, with goats in T_3 having the major decrease in body weight gain. The general decrease in body weight gain may be due to the health challenges faced by the goats as a result of the season (rainy season), with those in T_3 having the worst hit. The various ailments generally faced by the experimental goats were treated. It is however possible that the goats in this treatment did not fight the ailments like others did (the place of individual difference). Rainy season encourages many livestock diseases which lead to weight lost. Total confinement throughout the period of the study might have also prevented the experimental goats from performing maximally since goats (especially WAD goats) are known not to thrive well under complete confinement. Mayard (1972) and Habeeb *et al.* (1992) reported that different environment significantly affects performance of animals in all aspect of production.

4.3. Dry Matter and Nutrient Digestibility of West African Dwarf Goats Fed Sun-Dried Cashew Pulp-Based Diets

The dry matter and nutrient digestibility of West African Dwarf Goats fed diets containing sun-dried cashew pulp based meal showed that crude fibre and ether extract were affected by the level of inclusion of sun-dried cashew pulp. Values for dry matter ranged from 91.14% in T_4 – 95.44% in T_1. The value for dry matter in this study is higher than 76.43% - 84.42% reported by Okoruwa and Adewumi (2010) who studied the effect of replacing *Panaicum maximum* with dried pineapple pulp on nutrient digestibility and nutrient balance of WAD sheep. Crude protein digestibility in this study was between 48.52% in T_4 – 54.99% in T_1 which shows that the percentage digestibility of crude protein reduced as the inclusion level of sun-dried yellow cashew pulp increased. This is lower than 72.91% - 91.89% ($p < 0.05$) reported by Okoruwa and Adewumi (2010). The value for crude protein digestibility in this study is close to the 50.70% - 65.40% reported by Anigbogu *et al.* (2007), who

evaluated the production performance of WAD goats on varying forage/concentrate ratio – feeding system. The low crude protein digestibility coefficient in this study may have been due to the very high crude fibre content of the experimental feeds as observed from the proximate analysis table (Table 3). Treatment one (T_1) with the highest crude protein digestibility coefficient also has the lowest crude fibre content. The crude fibre digestibility coefficients in this study ranged from 52.32 in T_3 – 61.77 in T_1. The values for crude fibre in T_1 and T_2 were higher than for other treatments. This is lower than 75.63 - 85.85% reported by Okoruwa and Adewumi (2010). This variation may be as a result of differences in the crude fibre value of the diet as well as type of fibre fraction, and their levels in the various diets. The values for ether extract in T_1 and T_4 were higher than for other treatments. Values of ether extract digestibility in this study were fairly high, ranging from 66.64 in T_2 – 73.20 in T_1. These values are lower than 80.65 - 88. 10% reported by Okoruwa and Adewumi (2010).

The averagely high digestibility coefficient of most of the nutrients in this study may have been due to the very high crude fibre content of the experimental feeds which would have affected other nutrients. The nature of the experimental feed, which is completely made up of non-conventional feed stuffs with high individual crude fibre would have brought about the high crude fibre content of the feed. Though ruminants have the ability to digest fibre, very high levels could negatively affect digestion.

5. Conclusion and Recommendation

The nutritional evaluation of the potentials of sun-dried yellow cashew pulp meal in the diets of West African dwarf goats reveals that the inclusion of sun-dried cashew pulp meal up to 30% did not adversely affect performance parameters. It is recommended that Goat producers should use sun-dried yellow cashew pulp meal up to 30% inclusion level in the diets of their goats. Also, total confinement of WAD goats of this age bracket (6-7 months) throughout the period of this study was carried out and it appeared that this prevented the experimental goats from performing maximally. Therefore, total and complete confinement of WAD goats of this age bracket (6-7 months) for a long period of time is highly discouraged. Furthermore, more studies should be carried out using animals of different age bracket and different species and breeds of animals.

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