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Carcass Characteristics, Internal Organs and Economics of Feeding Sun-Dried Yellow Cashew Pulp Based Diets to West African Dwarf Goats

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Abstract: The carcass characteristics, internal organs and economics of feeding sun-dried cashew pulp based diets to West African Dwarf (WAD) Goats were studied. 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 carcass and internal organ parameter was significantly affected ($P > 0.05$) by the inclusion of sun-dried cashew pulp meal. Total feed cost and total variable cost were highly significantly affected ($P < 0.01$) and feed cost per kg, total feed cost and total variable cost of production reduced as the inclusion level of sun-dried cashew pulp increased from 0% (control) – 30%. 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 in known to be the highest cashew producing state in Nigeria and the pulp unlike the seed are left to waste during its season.

Keywords: Yellow Cashew Pulp, Carcass Characteristics, Internal Organs, Economics of Feeding

1. Introduction

The major constraint to ruminant animal production in Nigeria apart from the problem of diseases is the shortage of dry season feed, particularly shortages of forage. Grasses which are the most abundant basal feed for ruminants most of the times dry up and become low in nutritive value thereby leading to a marked decrease in voluntary intake and digestibility (Yusuf *et al*., 2013). Also livestock farmers in developing countries are faced with various challenges that lead to considerable fall in the production of certain livestock species like goats, cattle, swine and poultry, which further leads to protein shortage. This is due to the high cost of production that originates from increase in prices of conventional feed ingredients and livestock species.

According to Lamorde (1991), protein intake in North America, Western and Eastern Europe has been put at 66 g, 39 g and 35 g per head per day respectively, while in Africa and indeed Nigeria the figure stands at 11 g per head per day. Regrettably, animal products contribute 15 to 20% of total protein intake of Nigerians (Federal Republic of Nigeria, 1997). It was further reported that protein from animal sources contribute about 17% of the total consumption to the average Nigerian diet compared to a contribution of about 61% to the total consumption in Newzealand,60% in U. K, 71% in the USA and 67% in Denmark (Qureshi and Fitzhugh, 1997).

Goats, like cattle, have played an important role in the

livelihood of rural people in Africa. Indigenous goats are more common than the improved goats. These local goat breeds constitute valuable sources of genetic material because of their adaptation to harsh climatic conditions, their ability to better utilize the limited and poor quality feed resources and their resistance to a range of diseases such as internal parasites and others. They also 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 pulp is considered as a waste in cashew nut processing industry. Although there is growing awareness surrounding the economic importance of cashew production in Asian and African countries, the present practice in most established large-scale plantations is to allow the apples to fall from the trees naturally before harvesting the nuts. This contributes a gross waste of this versatile cashew product (Shuklajasha *et al*., 2006). Muniz *et al*. (2006) also corroborated the manner in which cashew apple pulp has been underutilized, and therefore suggested the development of a new product to minimize the pulp waste by fermenting the juice, yielding an alcoholic beverage such as wine. The pulp of cashew apple is very juicy, but the skin is fragile. When these fruits are dried, they turn brown due to effect of heat on them and these can be incorporated in feed to be fed to animals such as cattle and goats. It is rich in Vitamin C than oranges and contains high amount of mineral salts (Deckers *et al.,* 2001; Denise *et al.,* 2002).

The utilization of abundant cashew pulp in cashew growing areas like Kogi State, Benue State etc, will help to reduce the waste that characterizes cashew production season. According to personal interview with the staff of Cocoa Research Institute of Nigeria (who has cashew as one of their mandate crops), Kogi state is the highest cashew producing state in Nigeria.

2. Materials and Methods

2.1. Procurement and Preparation of Varieties of Cashew Pulp

The sample of 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.

2.2. Location of the Study

This study was carried out in the Sheep and Goat Unit of the Teaching and Research farm of Kogi State University, Anyigba. Anyigba is located on longitude 07°30' N and latitude 07°09' E (Kogi State Agricultural Development Project, 2010). The study area falls within the tropical wet and dry climatic region and the guinea savanna belt of Nigeria. The mean annual rainfall and temperature of 1250 mm and 25°C respectively (Ifatimehin and Ufuah, 2006).

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.

2.3. Experimental Procedure, Management and Duration of Study

A total of twenty male West African Dwarf goats of about 6-7 months, having an average initial weight of 6.42 kg were obtained from goat producers within Anyigba town for this experiment. Goats were housed in wooden cages in the pens. Each cage measured (100 x 85 x 60) cm and the cages were built on wooden stands, 40 cm from the floor. Before the goats were brought in, the pens were cleaned, washed and disinfectant with detol and izal solution. The entire goat house was fumigated using strong fumigants (Dimethoate 40% and Action 40%) against fleas. Prophylactic treatments were given to all the goats: they were dewormed using Albendazole oral and ivermectin (vetomech), and also vaccinated against PPR using PPR vaccine, subcutaneously. Iron injection (iron dextrin) was administered and Ivax was also administered orally to combat diarrhoea, tylosan intramuscularly to fight against cold and catarrh. Treatment against ecto-parasites was done with the use of Amitraz solution. Multivitamin was also administered to boost appetite. Antibiotics such as oxytetracycline (long acting) were administered. The goats were randomly distributed to 4 groups of 5 animals each. Each goat served as a replicate. An

adjustment period was allowed for the goats before data collection commenced. Goats were fed daily between the hours of 8:30 am and 9:30 am based on 5% body weight. Left over feeds and water were weighed and measured daily to facilitate calculation of feed and water intake. Weighing of the goats was done weekly to determine the weight and feed conversion ratio. The experiment commenced in the month of August and lasted for a period of 107 days.

2.4. Carcass and Internal Organ Parameters

At the end of the experiment, two (2) goats per treatment, and a total of eight (8) goats were used for carcass evaluation. The selected goats were fasted for 24 hours prior to slaughter, providing them with only water, after which they were weighed to obtain live weight, and slaughtered. The slaughtered goats were roasted, internal organs removed and weighed to get the carcass weight (head, legs, kidneys, heart and liver were left on the carcass and considered as carcass weight). Dressing percentage was calculated by working the percentage of the ratio of the weight of carcass to the live weight. Internal organs were weighed using the electronic weighing scale in order to obtain more accurate values. The followings were evaluated:

(i) Live weight
(ii) Carcass weight
(iii) Dressing percentage (%)
(iv) The following parts were weighed: head, neck, thigh, legs, heart, lungs, liver, kidney, spleen, testes, full gut and empty gut.

All these parts were calculated as percentage live weight.

2.5. Determination of the Economics of Feeding Sun-Dried Cashew Pulp Based Diet to West African Dwarf Goats

The economics of feeding dried cashew pulp based diet to West African Dwarf goats were calculated and determined using some basic formulae as shown below:

Total Variable Cost of Production = Cost of Goat + Cost of other variable inputs

Gross Margin = Selling Price (Revenue) – Total Variable Cost of Production

$$\text{Cost Benefit Ratio} = \frac{\text{Revenue}}{\text{Total Variable Cost of Production}}$$

Total Feed Cost = Total Feed Intake x Cost of Feed/kg.

Feed Cost per Kg Gain = Feed Conversion Ratio x Feed Cost.

2.6. Effect of Feeding Sun-Dried Cashew Pulp Based Diets on Carcass Characteristics and Internal Organs of Experimental Goats

The effect of feeding sun-dried cashew pulp based diets on carcass characteristics of experimental goats is presented in Table 2. None of the carcass parameter was significantly affected ($P > 0.05$) by the inclusion of sun-dried cashew pulp meal. Live weight ranged from 7590.00 (T_3) – 8325.00 (T_2); Carcass weight ranged from 4360.00 (T_3) – 4755.00 (T_2); dressing percentage ranged from 55.99 (T_1) – 57.66 (T_3); head ranged from 7.40 (T_2) – 8.06 (T_3); neck ranged from 3.37 (T_1) – 4.03 (T_2); thighs ranged from 17.65 (T_3) – 19.34 (T_1); legs ranged from 2.38 (T_2) – 2.84 (T_3); heart 0.53 (T_2 and T_3) – 0.59 (T_1); lungs ranged from 1.22 (T_2) – 1.41 (T_1); liver ranged from 1.99 (T_3) – 2.37 (T_2); kidneys ranged from 0.38 (T_1 and T_2) – 0.41; spleen ranged from 0.15 (T_3) – 0.19 (T_1); testes ranged from 1.00 (T_1) – 1.49 (T_2); full gut ranged from 28.18 (T_2) – 34.38 (T_3) and empty gut ranged from 8.99 (T_1) – 9.33 (T_3).

Table 2. *Effect of Feeding Sun-dried Cashew Pulp Based Diets on Carcass Characteristics and Internal Organs of Experimental Goats.*

Experimental Diets					
Parameters	**T_1 (0%)**	**T_2(10%)**	**T_3(20%)**	**T_4(30%)**	**SEM**
Live Weight (g)	7860.00	8325.00	7590.00	7925.00	340.43^{ns}
Carcass Weight (g)	4400.00	4755.00	4360.00	4505.00	174.99^{ns}
Dressing Percentage (%)	55.99	57.42	57.66	56.75	0.78^{ns}
Head (% LW)	7.92	7.40	8.06	7.72	0.24^{ns}
Neck (%LW)	3.37	4.03	4.00	3.81	0.14^{ns}
Thighs (% LW)	19.34	18.53	17.65	18.35	0.45^{ns}
Legs (% LW)	2.57	2.38	2.84	2.61	0.08^{ns}
Heart (% LW)	0.59	0.53	0.53	0.54	0.02^{ns}
Lungs (% LW)	1.41	1.22	1.26	1.30	0.05^{ns}
Liver (% LW)	2.02	2.37	1.99	2.15	0.07^{ns}
Kidneys (% LW)	0.38	0.38	0.41	0.39	0.01^{ns}
Spleen (% LW)	0.19	0.17	0.15	0.17	0.01^{ns}
Testes (% LW)\	1.00	1.49	1.39	1.28	0.10^{ns}
Full Gut (%LW)	30.86	28.18	34.38	30.46	0.94^{ns}
Empty Gut (%LW)	8.99	9.29	9.33	9.23	0.17^{ns}

SEM = Standard Error of Mean, ns = not significant, %LW = Percentage live weight.

2.7. Effect of Feeding Sun-Dried Cashew Pulp Based Diets on Economics of Production of Goats

The effect of feeding sun-dried cashew pulp based diets on economics of production of goats is presented in Table 3. Total feed cost and total variable cost were highly significantly affected ($P < 0.01$) by the inclusion of sun dried cashew pulp meal. All other parameters under the economics of feeding sun-dried cashew pulp to goats were not significantly affected ($P > 0.05$). Values for feed cost per kg

ranged from 11.05 (T_4) – 18.06 (T_1); feed cost per kg gain values ranged from 338.79 (T_4) – 948.56 (T_3); protein efficiency ratio ranged from 0.01 (T_4) – 0.27 (T_4); energy efficiency ratio ranged from 0.001 (T_2, T_3, T_4) – 0.009 (T_1); total feed cost ranged from 247.23 (T_4) – 426.40 (T_1); total variable cost of production ranged from 4956.40 (T_4) – 5135.60 (T_1); gross margin ranged from 894.74 (T_3) – 1046.70 (T_2) and cost benefit ratio ranged from 1.180 (T_3) – 1.210 (T_4).

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

Experimental Diets					
Parameters	**T_1 (0%)**	**T_2 (10%)**	**T_3 (20%)**	**T_4 (30%)**	**SEM**
Feed Cost per kg (N/kg)	18.06	15.92	13.52	11.05	-
Feed Cost per kg Gain (N/kg)	365.17	601.14	948.56	338.79	124.38^{ns}
PER	0.27	0.15	0.07	0.10	0.08^{ns}
EER	0.009	0.001	0.001	0.001	0.002^{ns}
TFC (N)	426.40^{a}	344.09^{b}	296.09^{bc}	247.23d	19.54^{**}
TVCP (N)	5135.60^{a}	5053.30^{b}	5005.30^{bc}	4956.40^{d}	19.54^{**}
Gross Margin (N)	964.43	1046.70	894.74	1043.60	59.53^{ns}
CBR	1.188	1.208	1.180	1.210	0.011^{ns}

a, b, c, d = Means with different superscripts on the same row are significantly different ($P < 0.01$)
SEM = Standard Error of Mean, ns = not significant, ** = Significant at ($P < 0.01$)
PER = Protein Efficiency Ratio
EER = Energy Efficiency Ratio
TFC = Total Feed Cost
TVCP = Total Variable Cost of Production
CBR = Cost Benefit Ratio

3. Discussion

3.1. Effect of Feeding Sun-Dried Cashew Pulp Based Diets on Carcass Characteristics and Internal Organs of Experimental Goats

None of the carcass and internal organ parameters was affected by the inclusion of sun-dried cashew pulp meal. The cashew apple meal inclusion in animal diets did not influence dressing percentage, weight of spleen, gizzard, and heart but there was a significant reduction in liver size ($P < 0.05$) (Kardivel *et al*., 1993). Dressing percentage in this study ranged from 55.99% – 57.66%. The dressing percentage in this study is higher than 43.80% - 47.30% reported by Ukanwoko *et al.* (2009) who fed cassava peal meal-based diets to WAD goats. Aliyu *et al.* (2007) reported dressing percentages of 39.99%, 41.17% and 45.41% for Balaami, Uda and Yankassa sheep respectively. These dressing percentages are lower than the result obtained in this study. Omojola and Attah (2006) who studied the carcass and non-carcass components of male WAD goats slaughtered at different weights (10 -20 kg) reported a dressing percentage of 40.02% - 56.88% ($P < 0.05$) which is close to that obtained in this study. The variations in dressing percentages across the various studies cited might be due to difference in slaughter technique, breed, nutrition (Fasae *et al.*, 2007), and body weight (both initial and final). This goes in line with the contributions of Cassey and Van Neikerk (1988), who reported that dressing percentage, can be influenced by many factors such as fleece and hide weight, alimentary tract size and fill, slaughtering procedure and partitioning of body fat. Also the dressing method can affect the dressing percentage because, parts which are considered offals may not be considered offal in some dressing methods. An example is that of Fasae *et al*. (2007) who consider hot carcass weight to be carcass weight – legs + head, and normal carcass weight as Empty body weight – Gastro- intestinal tract (GIT). By so doing, calculation of dressing percentage as recommended by Fasae *et al*. (2007) will give a rather higher value when compared to Ukanwoko *et al.* (2009) who reported warm carcass to exclude all internal organs, the skin, the head, the feet as well as viscera and abdominal fat. Age, nutrition, sex, pre-slaughter weight, gut fill and slaughter by-products are some of the factors that affect carcass characteristics (Vergara *et al*., 1999). Carcass weight in this study ranged from 4360.00 g in T_3 – 4755.00 g in T_2. This could mean that goats on sun-dried cashew apple pulp-based diet better utilised feed for meat production, particularly goat under T_2. This can be further explained by the higher neck weight for goats on diets containing sun-dried cashew pulp meal when compared to those on the control diet. The weight of the head, neck thighs, legs, heart, lungs, liver, kidneys, spleen, testes, full gut and empty gut in this study were all expressed as percentage live weight. They were not affected by the inclusion of sun-dried cashew pulp meal. The decrease in the weight of the head as the carcass weight increased agrees with the study by Omojola and Attah (2006). Internal organs such as the liver would vary by enlargement if the diets contained poisonous substances. The non- significance in the internal organs could mean that the test diet is safe for the animal's consumption. Heart weight in this study was almost similar for all the treatments. This is a good sign since abnormal blood circulation would cause variation in the size of the heart (Frandson, 1986). Non- significance between the values for heart is an indication that blood circulation of goats placed in all the treatment was normal. This also shows that the kidneys (excretory organ) were not over burdened by the inclusion of sun-dried cashew pulp meal in the dietary treatments, thus its excretory function was not impaired (Ngi, 2012).

3.2. Effect of Feeding Sun-Dried Cashew Pulp Based Diets on Economics of Production of Goats

The effect of feeding sun-dried cashew pulp based diets on economics of production of goats shows that total feed cost and total variable cost were highly affected by the inclusion of sun dried cashew pulp meal. All other parameters were not affected. Values for feed cost per kg in this study ranged from N11.05 in T_4 – N18.06 in T_1 and this is lower than N16.00 - N36.00 reported by Kalio *et al*. (2013) who fed crop by-products (peels of yam, cassava, sweet potato and ripe

plantain) to West African Dwarf bucks. The feed cost per kg in this study is this low, considering the fact that the feed was completely made up of non-conventional feed stuffs. The feed cost per kg obtained in this study shows that the feed cost per kg reduced from T_1 to T_4 as the inclusion of cashew pulp increased from 0% in T_1 to 30% in T_4. Feed cost per kg gain in this study ranged from 338.79 in T_4 – 948.56 in T_3. This is higher than N169.17 – 214.30 reported by Kalio *et al*. (2013). The very high feed cost per kg gain (948.56) obtained for T_3 in this study is as a result of a decrease in body weight gain of the experimental WAD goats which led to a very high FCR in T_3 since feed cost per kg gain is the product of FCR (ratio of the total feed consumed in grammmes and total weight gained in grammmes per treatment) and feed cost per kg. 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 total feed cost for T_1 was higher than for other treatments. The total variable cost of production for T_1 was higher than for other treatments. Total variable cost of production in this study ranged from N4956.40 in T_4 - N5135.60 in T_1 and it is a true indication of the effect of the feed cost in the overall goat production as reflected in the total cost of feed consumed in which T_1 had the highest value while T_4 had the least. Gross margin in this study ranged from N894.74 (T_3) – N1046.70 (T_2) and this shows that more profit can be generated by farmers with increased level of sun-dried cashew pulp meal inclusion in goat diets. Cost benefit ratio ranged from 1.180 (T_3) – 1.210 (T_4), which means that farmers can acquire more benefits and less cost from the use of sun-dried cashew pulp as a feed stuff in livestock feed.

4. Conclusion and Recommendations

Studies on carcass characteristics, internal organs and economics of feeding sun-dried yellow cashew pulp based diets to West African Dwarf Goats showed that yellow cashew pulp sun-dried at 30% inclusion had no adverse effect on carcass characteristic, internal organs and economics of production. This is supported by the fact that none of the carcass and internal organ parameters was affected by the inclusion of sun-dried cashew pulp meal ($p > 0.05$).

Feed cost per kg, total feed cost and total variable cost of production reduced as the inclusion level of sun-dried cashew pulp increased from 0% (control) – 30%.

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