# Growth performance, nutrient digestibility and carcass characteristic of growing rabbits fed cashew apple waste

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## Abstract

The nutritve value of dried cashew apple waste (CAW) was investigated in this study. A basal (control) diet was formulated to meet requirements of growing rabbits and three other diets were formulated by substituting 10, 20 and 30% of the basal diet with CAW. Thirty six 6-week old rabbits were fed these diets and growth performance was recorded. Faecal apparent digestibility of nutrients was measured in 12 rabbits.

Rabbits fed diets with 20 and 30 % CAW gained weight (P< 0.05) faster than those fed the control diet. Feed efficiency increased with levels of CAW in the diets with rabbits on 30% CAW being most efficient. Crude protein digestibility decreased (P< 0.05) with increased level of CAW. There were no significant differences (P> 0.05) in the blood metabolites except cholesterol level which increased (P< 0.05) with CAW inclusion in the diets. Inclusion of CAW also increased (P< 0.05) the relative weights of kidney, liver and carcass cut parts.

It is inferred that dried CAW can be included in growing rabbit diets up to 30% of the dry matter.

*Key Words: Cashew apple waste, digestibility, performance, rabbits*

## Introduction

The inclusion of alternative feedstuffs in animal diets might be interesting in some circumstances (relative price, feed quality), but it is limited because of the lack of information on their nutritive value. This is the case with cashew apple waste (CAW), a by-product generated from the extraction of juice from the cashew apple.

Cashew (*Anacardium occidentale*) is native to tropical central and south America and the West Indies but has become naturalised in many other tropical countries. Cashew is hardy and drought-resistant; it grows well in most tropical soils and climates. The nut is obviously an important product of the cashew tree, but this tree also yields the pear-shaped apple to which the nut is attached. The cashew apple was relatively neglected until recently, although it is available in considerable quantities. A number of processes have now been developed for converting the apple into various products such as juice, jam, syrup, chutney and beverage (Winterhalter 1991; La Van Kinh et al 1997).

Falade (1981) reported that the sugar content of cashew apple ranged from 1.5 to 4.5 g per litre of juice. La Van Kinh et al (1997) gave the composition of the whole fruit in percent of dry matter (DM, 12.32%) as 3.54, 1.62, 0.03, 0.07 and 54.7 for crude fibre (CF), ash, Ca, P and total sugars, respectively, while the composition of the CAW in percent of DM (22.5%) was 11.8, 1.0, 0.25, 0.34 and 26.5 for CF, ash, Ca, P and total sugars, respectively. In the trials reported by La Van Kinh et al (1997), when CAW was ensiled with poultry litter, the soluble sugars were converted into organic acids and alcohol, which may have had negative effects on nutritive value, while dry CAW may be a promising product for monogastric animal feeding (La Van Kinh et al 1997).

The present paper reports experiment designed to investigate the performance, blood biochemical indices and carcass quality of growing rabbits fed sun-dried CAW.

## Materials and Methods

### Diets

CAW collected from the fruit processing unit of the Department of Food Science and Technology, University of Agriculture, Abeokuta,Nigeria was sun-dried for 3 days, then oven-dried and ground in a hammer mill. The contents of crude protein (CP), CF, ether extract (EE) and ash were 187, 84, 24 and 54 g/kg DM, respectively. A basal (control) diet was formulated and three other diets by substituting 10, 20 and 30% of the basal diet with CAW (Table 1).

**Table 1 :** Composition of experimental diets (%)

| | **Levels of cashew apple waste in diets (%)** | | | |
|---|---|---|---|---|
| | **0** | **10** | **20** | **30** |
| Maize | 48.0 | 48.0 | 48.0 | 48.0 |
| Full fat soyabean | 15.0 | 14.0 | 13.0 | 12.0 |
| Cashew pulp waste | - | 10.0 | 20.0 | 30.0 |
| Blood meal | 2.0 | 2.0 | 2.0 | 2.0 |
| Wheat bran | 31.4 | 22.4 | 13.4 | 4.4 |
| Oyster shell | 2.0 | 2.0 | 2.0 | 2.0 |
| Bone meal | 1.0 | 1.0 | 1.0 | 1.0 |
| Salt | 0.3 | 0.3 | 0.3 | 0.3 |
| Premix | 0.3 | 0.3 | 0.3 | 0.3 |
| **Composition (%)** | | | | |
| Dry matter | 89.0 | 89.8 | 89.6 | 90.4 |
| Crude protein | 16.51 | 16.60 | 16.68 | 16.76 |
| Crude fibre | 13.18 | 11.65 | 10.88 | 10.14 |
| Gross energy (MJ/kg) | 13.34 | 12.39 | 12.45 | 12.50 |

## Animals

Thirty six 6-week old weaner rabbits (New Zealand White X Flemish Giant), with a mean weight of 358± 6.34g were assigned to the 4 dietary treatments, and the animals in each treatment were kept in three cages of 180 x 45 cm, with 3 rabbits in each. Feed and water were freely available. Rabbit weight and feed consumption were recorded weekly to calculate weight gain and feed conversion.

## Digestibility Trial

Twelve rabbits were assigned to the four experimental diets. Faeces from each rabbit were collected on day 8, 9 and 10 in labelled polyethylene bags and stored at $-10^{\circ}$ C. Composition of feed and faecal samples was determined using the techniques outlined by AOAC (1990). Faecal apparent digestibility of DM, CP, CF, EE and nitrogen free extract (NFE) were determined for each diet.

## Blood analysis and carcass trait measurement

Three rabbits per treatment were selected and bled before the morning feeding in the last week of the experiment. About 5 ml of blood was immediately collected from each rabbit into sample bottles containing Ethylene Diamine Tetra-acetic acid (EDTA) as anti-coagulant and into other bottles without EDTA for serum metabolites. The blood was analysed for haemoglobin, red blood cell, white blood cell, total protein, albumin, urea, creatinine, cholesterol, serum glutamic oxaloacete transaminase (SGOT) and serum glutamic pyruvic transaminase (SGPT). The blood chemistry data were obtained according to procedures reported by Onifade and Tewe (1993) and Onifade et al (1999).

At the end of the feeding period, feed was withheld overnight and the rabbits slaughtered. The weights of the cut parts viz. hind and fore limbs, lumbar region, thoracic region and breast were determined, so also were the weights of the liver, kidneys, heart and lungs.

## Carcass sensory evaluation

Lumbar region and hind limb muscle meat were evaluated one week after slaughtering. Frozen meat was thawed with the bone intact. The meat was cooked at $170^{\circ}$ C in a conventional preheated gas oven for 20 mins. Cooked meat was removed from the oven, allowed to cool for 10 mins, deboned and muscles cubed and then served to a 20-member trained panel drawn from the University community. A modified hedonic scoring scale was employed (Williams and Damron 1998). The panellists were instructed to score each sample for juiciness, flavour intensity, tenderness, off-flavour and overall acceptance. Eight point scales were employed for juiciness, flavour intensity, and tenderness where 8 – extremely juicy/intense/tender, 7-very juicy/intense/tender, 6 – moderately juicy/intense/tender, 5 – slightly juicy/intense/tender, 4 – slightly dry/bland/tough, 3- moderately dry/ bland/tough, 2 – very dry/bland/tough and 1 – extremely dry/bland/tough. A six point scale was employed for off-flavour where 6 – none detected, 5 – threshold, barely detected, 4 – slight off-favour, 3 – moderate off-flavour, 2 – strong off- flavour, and 1 – extreme off-flavour.

### Statistical Analysis

Data collected were subjected to analysis of variance as outlined by Daniels (1995). When analysis of variance indicated significance for treatment effects, specific differences between means were detected by the Duncan Multiple range test (Duncan 1955).

## Results

### Growth Performance

Rabbits fed diets with 20 and 30% CAW gained weight faster (P< 0.05) than rabbits fed diets without CAW while there was no significant difference in weight gain between 10% CAW and control diets (Table 1). The increase in the growth rate of animals on 20 and 30% CAW diets led to an improvement (P< 0.05) in the feed conversion ratio.

**Table 2.** Mean values (with SEM) for performance and apparent nutrient digestibility of rabbits fed increasing levels of cashew apple waste

| | **Level of cashew apple waste in diet (%)** | | | |
|---|---|---|---|---|
| | **0** | **10** | **20** | **30** |
| Weight gain, g/day | 15.2$^{b}$±1.50 | 15.0$^{b}$±1.10 | 17.0$^{a}$±1.40 | 18.9$^{a}$±1.33 |
| Feed intake, g/day | 66.8±0.22 | 62.6±0.29 | 65.0±0.25 | 61.3±0.21 |
| Feed conversion | 4.40$^{a}$± 0.22 | 4.16$^{a}$±0.31 | 3.82$^{c}$± 0.12 | 3.25$^{d}$±0.21 |
| Digestibility (%) | | | | |
| Crude protein | 83.03± 0.57 | 83.25±0.98 | 84.58±1.00 | 83.64±0.80 |
| Ether extract | 84.51±0.37 | 85.84±0.42 | 85.21±0.54 | 85.80±0.32 |
| Crude fibre | 85.96$^{a}$±1.47 | 3.89$^{b}$±1.20 | 878.26$^{c}$±1.37 | 80.60$^{c}$±1.40 |
| Nitrogen free extract | 85.20±0.54 | 84.72±0.50 | 85.62±0.67 | 85.67±0.57 |

*abc: Mean values in row without letter in common are different at P<0.05*

### Nutrient Digestibility

There were no differences (P> 0.05) in the apparent nutrient digestibility of CP, EE or NFE in rabbits fed the different diets (Table 2). Apparent digestibility of CF decreased (P< 0.05) with increase in the level of CAW in the diets.

### Blood Biochemical Parameters

No differences (P> 0.05) were observed among the dietary groups for enzyme activities (SGPT, SGOT) and other blood metabolites except cholesterol,  which increased (P<0.05) with CAW inclusion in diets (Table 3).

**Table 3 :** Mean values (with SEM) of blood biochemical indices of rabbits fed increasing levels of cashew apple waste

| | **Levels of cashew apple waste in diets (%)** |
|---|---|

| | 0 | 10 | 20 | 30 |
|---|---|---|---|---|
| Haemoglobin (g/100ml) | 12.00±3.00 | 14.30±0.30 | 13.80±0.50 | 14.70±0.50 |
| Red blood cell (mil/mm$^3$) | 4.00±1.00 | 4.80±0.60 | 4.60±0.33 | 5.00±1.00 |
| White blood cells (no/mm$^3$) | 5200±100 | 5000±100 | 5200±50 | 5400±150 |
| Total protein (mg/100ml) | 58.00±2.00 | 69.00±5.00 | 66.00±5.00 | 70.00±3.00 |
| Albumin (mg/100ml) | 35.00±2.00 | 41.00±3.00 | 40.00±1.00 | 42.00±2.00 |
| Urea (mg/100ml) | 29.00±5.00 | 34.00±2.00 | 33.00±3.00 | 35.00±4.00 |
| Creatinine (mg/100ml) | 1.30±0.20 | 1.40±0.20 | 1.40±0.10 | 1.50±0.20 |
| Cholesterol (mg/100ml) | 166.00$^c$±1.00 | 198.00$^a$±2.00 | 189.00$^a$±1.00 | 202.00$^a$±2.00 |
| SGOT (IU/litre) | 37.00±1.00 | 39.00±2.00 | 38.00±2.00 | 39.00±1.00 |
| SGPT (IU/litre) | 36.00±2.00 | 37.00±2.00 | 37.00±1.00 | 38.00±1.00 |

*abc: Mean values in row without letter in common are different at P<0.05*

## Carcass Traits and Meat Quality

Generally, CAW increased (P<0.05) the relative weight of the carcass traits. No significant difference for the weights of heart and lungs between treatments were observed. The weights of kidneys and liver of rabbits fed CAW diets were significantly (P< 0.05) higher than those in the control diet. There were no significant effects (P> 0.05) on juiciness, flavour, tenderness, off-flavour or overall acceptance among the meat samples from rabbits fed 0, 10, 20 or 30% CAW (Table 4).

**Table 4**. Mean values (with SEM) of rRelative weight (as % live weight) of carcass traits of rabbits fed graded levels of Cashew apple waste

| | **Level of cashew apple waste (%)** | | | |
|---|---|---|---|---|
| Parameters | **0** | **10** | **20** | **30** |
| Head | 7.54$^b$ ±0.06 | 7.44$^b$ ± 0.13 | 8.65$^a$ ±0.13 | 8.95$^a$ ±0.03 |
| Hind limb | 11.38$^c$ ± 0.12 | 13.22$^b$ ± 0.12 | 16.06$^a$ ±0.12 | 15.87$^a$ ±0.12 |
| Fore limb | 9.70$^b$ ±0.12 | 8.00$^c$ ±0.12 | 11.06$^a$ ±0.12 | 9.75$^b$ ±0.12 |
| Breast | 0.68$^b$ ±0.12 | 1.23$^a$ ±0.12 | 1.36$^a$ ±0.12 | 0.64$^b$ ±0.12 |
| Lumber region | 10.89$^c$ ± 0.12 | 10.98$^c$ ± 0.12 | 16.05$^a$ ±0.12 | 14.00$^b$ ±0.12 |
| Heart | 0.19 ±0.05 | 0.29 ±0.05 | 0.30 ±0.05 | 0.34 ±0.05 |
| Lungs | 0.42 ±0.06 | 0.57 ±0.06 | 0.67 ±0.06 | 0.67 ±0.06 |
| Kidneys | 0.57$^c$ ±0.06 | 0.78$^b$ ±0.06 | 0.85$^a$ ±0.06 | 0.85$^a$ ±0.06 |
| Liver | 2.03$^c$ ±0.03 | 2.64$^b$ ±0.06 | 2.93$^a$ ±0.06 | 2.60$^b$ ±0.04 |
| Visceral organs | 17.44$^c$ ± 0.06 | 27.50$^b$ ± 0.06 | 28.13$^a$ ±0.06 | 15.00$^d$ ±0.06 |

*abc: Mean values in rows without letter in common are different at P<0.05*

## Discussion

The CP value of CAW in this study (18.7%) was higher compared to the 13.7% reported by La Van Kinh et al (1997) but lower in CF. A number of factors may be responsible for this difference. In addition to processing, storage may also be a factor.

The growth rates were generally lower than in rabbits fed conventional diets, but comformed with the general trend in developing countries (Cheeke 1986; Aduku et al 1988; Alawa et al 1989; Balogun and Etukude 1991). As shown in the digestibility study, the mechanisms directing the growth responses observed in the rabbits appear to be unrelated to nutrient digestibility. Although the growth rates of rabbits fed diets containing 20 and 30% CAW were better, there was no advantage in digestibility of CAW diets over the control. La Van Kinh et al (1997) indicated that fermentation of soluble sugars in CAW to organic acids and alcohol may have negative effects on nutritive value.

The superior performance of rabbits fed CAW diets was corroborated by the numerical increase in serum total protein and albumin. Total protein and albumin are good indices of the quality of dietary proteins (Eggum 1970; Lewis et al 1977). The cholesterol values for rabbits on the CAW diets were quite high. Kokatnur et al (1958) reported an increased linear relationship between serum cholesterol level and the absolute intake of protein. There were no significant differences in the blood urea concentration. According to Eggum (1976) and Oduguwa et al (2000), three factors influence blood urea concentration: the quantity of protein in the diet, the quality of protein in the diet, and the time of sampling after feeding. These three factors were similar in the dietary treatments except the quality of the protein mixture.

The hind limb and lumbar region are the most economically important portions of the carcass and also provide the greatest portions of edible meat in rabbits. Inclusion of CAW consistently increased the relative weight of these two cut parts. The observation that weights of lungs and heart in the rabbits were not significantly different further support the adequacy of the CAW diets. Green et al (1986) demonstrated that growth of organs can be inhibited when insufficient protein and amino acids are available. In our study the protein digestibility of the diets was similar. Contrarily, feeding CAW elicited higher ($P< 0.05$) weights of kidneys and liver.

Generally the sensory evaluation ratings of the meat from rabbits on the treatments were similar, indicating no adverse effect of feeding CAW on rabbit meat sensory quality.

## Conclusion

The data presented in this study show 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.

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