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# Effects of dried cashew (*Anacardium occidentale* L.) apple meal (DCAM) on the growth performance and internal organs of albino rats

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**ABSTRACT**

An experiment was conducted to ascertain the nutrient composition of dried cashew apple meal (DCAM) and the effect of diets containing varying levels of the DCAM on the growth performance, economics of production and the internal organs of albino rats. Sixteen rats with a mean initial weight of 64.7 g were randomly allotted to four isoproteic and isocaloric diets in a Randomized Complete Block Design based on their weight and sex. The diets were: T0 (0% DCAM), T1 (5% DCAM), T2 (10% DCAM) and T3 (15% DCAM). Each treatment had four replicates. Feed and water were provided *ad libitum*. Data collected were analysed using ANOVA of GenStat Discovery Edition 4. No differences occurred between diets for daily feed intake, daily weight gain and FCR. It cost \$0.009, \$0.016 and \$0.002 more for rats on T1, T2 and T3 respectively to gain 100 g of weight. No differences occurred between treatments for internal organs except for the relative weight of the empty GIT where rats on T3 had higher weight ($P < 0.05$). It was deduced that the DCAM could be useful in monogastric livestock feeding and could be added to a rate up to 15% of the diet.

**Keywords:** Agro-industrial by-products; albino rat; cashew; feed cost index; monogastric

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## Introduction

Feeding constitutes a greater fraction of the total cost of livestock production. Competition among humans, livestock, and manufacturing industries has led to the soaring prices of maize; a major conventional feedstuff in Ghana, due to the excess demand over the supply (Boateng *et al.,* 2008). Agro-industrial by-products (AIBP) promise to be a remedy to the escalated prices in conventional feed ingredients since some are affordable and several studies by scientists on the suitability of AIBP in animal feeding have yielded positive results (Manu *et al.,* 2015). In Ghana, a pool of various AIBPs are available which when fully exploited in feeding livestock could minimize the level of competition among humans and livestock and cause a reduction in the prices for the major and expensive conventional feedstuffs (Okai, 1998). Swain *et al.* (2014) noted that wastes and by-products from fruit processing industries could be employed in livestock and poultry feeding.

Cashew (*Anacardium occidentale* L.) is gradually becoming a common non-traditional crop for export in Ghana. Osei-Akoto *et al.* (2005) reported that different scales of cashew production farms exist in Ghana; with just a lower fraction (12%) of farmers operating on between 0.8 - 3.0 hectare of the land area whilst about 88% of the cashew farmers operate on 4 - 40-hectare land area. The nut, after processing, is commonly used as a flavouring agent in pastries (Liwayway *et al.,* 2013) and also as a snack. Large quantities of cashew apples are produced every year but the majority go to waste due to insufficient processing plants and the highly perishable nature of the material. According to the Ghana Export Promotion Authority (2018), cashew nut production level is approximately 70,000 metric tonnes. Earlier, Liwayway *et al.* (2013) had reported that cashew fruits are left to rot on the field after the nuts have been harvested. Runjala and Lakshman (2017) reported that cashew fruits have therapeutic and medicinal properties. Donkoh *et al.* (2012) fed dried cashew nut testa (DCNT) to albino rats and found no detrimental effect on the growth performance and carcass traits. The chaff and residue obtained from the processing of cashew apple could be dried and used in food as dietary fibre (Dedehou *et al.,* 2016). This study, therefore, sought to assess the nutrient composition of dried cashew apple meal (DCAM) and to determine its effect on the growth performance and carcass characteristics in the diets of monogastric using albino rats as a model.

## Materials and Methods

*Location and duration of the experiment*

The experiment was conducted at the Livestock Section of the Department of Animal Science, KNUST, Kumasi, Ghana, and the feeding trial lasted for four weeks. The study area lies in Altitude 261.4 MSL, Latitude 06$^{o}$ 41' N and Longitude 01$^{o}$ 33' W.

*Source and processing of the DCAM and the other feed ingredients*

Fresh ripe cashew fruits were picked from cashew trees at the Department of Animal Science, KNUST, Kumasi, Ghana after they had dropped from the trees to the ground. A total of 94 cashew fruits which weighed 6.32 kg were collected over three weeks. The cashew nuts were separated from the cashew fruits and weighed. The cashew apples were kept frozen in the refrigerator until it was needed. Prior to the feeding trial, the frozen cashew apples were thawed and oven-dried at a temperature of 60°C for 48 hours at the Nutrition Laboratory of the Department of Animal Science, KNUST, Kumasi-Ghana. The other ingredients used were sourced from the open market in Ejisu near Kumasi. The dried cashew apple together with the other ingredients was milled through a 2-mm sieve hammer mill.

*Proximate analysis of the DCAM*

The standard procedures described by AOAC (2002) were followed to assay for the percent moisture content (MC), crude protein (CP), crude fibre (CF), crude fat or ether extract (EE) and the ash content of the DCAM. The Nitrogen-free extract (NFE) was obtained by subtracting the sum of the percentage of CP, MC, CF, EE and Ash from hundred percent (100%) i.e. [100% - (% MC + % CP + % CF + % EE + % Ash)]. The metabolizable energy (ME) of the DCAM was estimated using the equation proposed by Pauzenga (1985) i.e. ME (kcal kg$^{-1}$) = [(37 × % CP) + (35 × % NFE) + (81.8 × % EE)] but those of the other ingredients used in formulating the experimental diets were retrieved from the NRC (1998).

*Experimental animals, diets and design*

Sixteen albino rats with a mean initial weight of 64.7 ± 0.74 g were obtained from the Rat Breeding Section of the Department of Animal

Science, KNUST, Kumasi-Ghana. The albino rats were blocked on the basis of their weight and sex and randomly allotted to four isoproteic (18%) and isocaloric (13 $MJkg^{-1}$) diets (Table 1). T0 i.e. control diet, contained no DCAM, while T1 had a 5% inclusion level of DCAM, and T2 and T3 had 10% and 15% inclusion levels of DCAM respectively in a Randomised Complete Block Design (RCBD). The DCAM was added to the diets mainly at the expense of maize.

*Housing and management*

The rats were kept individually in well-ventilated plastic cages measuring 25 x 20.5 x 15 cm. Each plastic cage was covered with wire mesh and was placed on shelves. There were perforations at the base of each cage to allow easy passage of faeces and urine. Feed troughs in the form of empty metal cans were tightly fitted to a corner of each cage using bolts and knots to prevent rats from spilling feed. Overhead bottle nipples were used as water drinkers.

TABLE 1

*Composition of the experimental diets (%)*

| | *Dietary treatments* | | | |
|---|---|---|---|---|
| *Ingredient (%)* | *T0 (0% DCAM)* | *T1 (5% DCAM)* | *T2 (10% DCAM)* | *T3 (15% DCAM)* |
| Maize | 59.0 | 53.0 | 48.0 | 42.0 |
| DCAM | 0.00 | 5.00 | 10.0 | 15.0 |
| Fish meal | 6.00 | 6.00 | 6.00 | 6.00 |
| Soya bean meal | 13.0 | 14.0 | 14.0 | 15.0 |
| Wheat bran | 20.0 | 20.0 | 20.0 | 20.0 |
| Oyster shell | 1.00 | 1.00 | 1.00 | 1.00 |
| Dicalcium phosphate | 0.50 | 0.50 | 0.50 | 0.50 |
| Salt | 0.25 | 0.25 | 0.25 | 0.25 |
| Vitamin trace-mineral premix[α] | 0.25 | 0.25 | 0.25 | 0.25 |
| Total | 100 | 100 | 100 | 100 |
| *Calculated composition* | | | | |
| Crude protein (%) | 18.0 | 18.3 | 18.2 | 18.1 |
| Crude fibre (%) | 4.20 | 4.44 | 4.67 | 4.89 |
| Calcium (%) | 0.88 | 0.92 | 0.96 | 1.00 |
| Phosphorus (%) | 0.76 | 0.81 | 0.86 | 0.91 |
| ME, kcal/kg | 3124 | 3136 | 3149 | 3162 |

[α]supplies Vitamin A 1.000.000 IU, Choline chloride 37.500 mg, Zinc 7.000 mg, Vitamin D3 200.000 IU, Manganese 6.000 mg, Vitamin E 1.000 mg, Vitamin K3 225 mg, Iron 4.500 mg, Vitamin B1 125 mg, Copper 500 mg, Vitamin B2 500 mg, Iodine 100 mg, Niacin 1.375 mg, Cobalt 100 mg, Vitamin PP 4.000 mg, Selenium 40 mg, Vitamin B6 125 mg, Antioxidant 500mgVitamin B12 1 mg, Folic Acid 100 mg, Biotin 1 mg. Minerals: Manganese oxide 6.000 mg, Zinc oxide 7.000 mg, Iron sulphate 4.500 mg, Copper sulphate 500 mg, Calcium iodine 100 mg, Cobalt carbonate 100 mg, Sodium selenite 40 mg per kg of the premix.

*Feeding and duration*
Feed and water were provided *ad libitum* throughout the feeding trial period which lasted four weeks. Feed allocation for a week was weighed and put into labelled plastic containers with air-tight lids. Feed was supplied from the plastic containers into the troughs as and when necessary. Drinkers were emptied and filled with fresh clean water every morning.

*Parameters Measured*

*Growth performance parameters and Economics of production*
Weekly feed intake and weight changes were measured and the values obtained from the measurement were used in calculating the average daily feed intake (ADFI), average daily weight gain (ADWG) and the feed to gain ratio (FCR) of the rats. The prevailing market prices of the various ingredients used in formulating and compounding the experimental diets, as at the time of the studies, were used to estimate feed cost, feed cost index (FCI) and the cost per 100 g weight gain. The cost of processing the DCAM was estimated and added to the DCAM diets.
Feed cost index (FCI) and FCR were reckoned as:

(a) $$\text{Feed cost index (FCI)} = \frac{\text{Cost of test diet}}{\text{Cost of the control diet}} \text{ X } 100$$

(b) $$\text{Feed Conversion Ratio (FCR)} = \frac{\text{Feed intake (g)}}{\text{Weight gain (g)}}$$

*Carcass traits measured*
At the end of the four weeks feeding trial, the rats were euthanized, dissected and the weights of the internal organs: viscera, heart, lungs, kidneys, liver, spleen and the full and empty gastrointestinal tract and stomach were measured using an electronic scale. The relative weight of the organs was estimated using the below formula.

$$\text{Relative weight of organ (\%)} = \frac{\text{Organ weight (g)}}{\text{Final live weight of rat (g)}} \times 100$$

*Statistical analysis*
Data obtained from the study were analysed using Analysis of Variance following the procedure outlined by GenStat Discovery Edition 4. Copyright 2011 and Tukey's range test was used to separate the means where differences among means were deemed significant (P< 0.05). The treatments (i.e., the different levels of the DCAM) were the fixed effects and the replications were the random effects.

## Results and Discussion

*Yield of cashew fruit and nutrient composition of DCAM*
In all, 94 cashew nuts were obtained and this weighed 0.65 kg representing 10.3% of the total weight of the whole fresh ripe cashew fruits collected. The fraction obtained for the cashew nuts corroborates the accession of Honorato *et al.* (2007) that cashew nut only represents 10% of the total weight of the cashew fruit. The false fruits i.e. cashew apples also weighed 5.67 kg. i.e. 89.7% of the entire fruit weight.

Table 2 illustrates the results obtained from the proximate analysis of DCAM. The percent composition of moisture, crude protein, crude fibre, crude fat, ash, and the nitrogen-free extract were 4.00, 5.45, 6.65, 3.00, 2.50 and 78.4 respectively. The value for the crude protein (5.45%) and crude fibre (6.65%) obtained in this study were lower compared to the 13.7 and 8.60 % CP, and 11.8 and 11.6% crude fibre reported by La van Kinh *et al.* (1997) and Armah (2011) respectively. As a result of the lower CP of DCAM compared to maize (8.7%) and to make the diets isoproteic, soya bean meal had to be increased as the proportion of DCAM increased in the diets (Table 1). It is worth noting that, the value obtained for the crude fibre content (6.65%) in this present study was the same as the findings of Castilo and Gerpacio (2005) for crude fibre (6.65%) of fresh cashew apple but that of the NFE (78.4%), found in this study, was higher than that reported by these authors (64.0%). Generally, the results for the proximate analysis point out that DCAM could be useful in livestock feeding. Again, the calculated metabolizable energy of the DCAM makes it a potential energy source for monogastrics as stated earlier by Armah (2011) who intimated that dried cashew pulp could partially replace the major conventional energy ingredients in livestock diets i.e. maize and wheat bran.

TABLE 2
*Nutrient composition of DCAM, (% 'As is' basis)*

| *Nutrient* | *Composition (%)* |
|---|---|
| Moisture | 4.00 |
| Crude protein | 5.45 |
| Crude fibre | 6.65 |
| Crude fat | 3.00 |
| Ash | 2.50 |
| Nitrogen–free extract | 78.4 |
| Metabolizable Energy (Kcal $Kg^{-1}$)$^{\beta}$ | 3191 |

$^{\beta}$Metabolizable energy for the DCAM was estimated using Pauzenga (1985) equation: ME (kcal $kg^{-1}$) = [(37×%CP) + (35×%NFE) + (81.8×%EE)]

*Growth performance and economics of production*

The data for growth performance and economics of production obtained in this study are shown in Table 3. No significant differences ($P$ > 0.05) were observed among the dietary treatments for feed intake, weight gain and feed conversion ratio. The non-significant difference ($P$ > 0.05) observed in this study for both daily and final weight gain is comparable to the findings of Liwayway *et al.* (2013) who reported no significant difference in bi-weekly weight gain among fattening hogs on a control, fresh and dried cashew apple diets. However, Fanimo *et al.* (2003) presented data to show that rabbits fed with diets containing cashew apple waste had improved growth performance and carcass traits. Earlier, Armah (2011) had reported that a 100 $gkg^{-1}$ inclusion rate of dried cashew pulp in the diet could improve the growth performance of pigs. Regardless of the increase of soya bean meal in the DCAM diets to make the diets isoproteic as reported earlier, the DCAM diets were cheaper as a result of the lower cost ($0.0044/100 g) of the DCAM. The feed cost index for this study revealed that it cost 4%, 8% and 12% less to compound dietary treatment T1, T2 and T3 respectively, meaning farmers could be able to reduce their feed cost when DCAM is incorporated in the diets of monogastrics. However, it cost $0.009, $0.016 and $0.002 more ($P$ > 0.05) for rats on 5%, 10% and 15% inclusion levels of DCAM respectively to gain 100 g of weight and this is because of the poorer FCR values obtained for the DCAM dietary treatments.

TABLE 3

*Growth performance and economics of production of albino rats*

| Parameter | Dietary treatments T0 | T1 | T2 | T3 | SEM | F pr. |
|---|---|---|---|---|---|---|
| Initial weight, g | 64.8 | 64.0 | 64.8 | 65.2 | 5.63 | 0.999 |
| Final weight, g | 159 | 146 | 138 | 145 | 7.09 | 0.267 |
| Total feed intake, g | 334 | 306 | 315 | 324 | 13.5 | 0.551 |
| Daily feed intake, g | 11.9 | 10.9 | 11.3 | 11.6 | 0.48 | 0.551 |
| Total weight gain, g | 94.2 | 82.2 | 73.0 | 79.8 | 6.28 | 0.186 |
| Daily weight gain, g | 3.37 | 2.94 | 2.61 | 2.85 | 0.22 | 0.186 |
| FCR (intake: gain) | 3.56 | 3.96 | 4.37 | 4.09 | 0.24 | 0.191 |
| Feed cost/100 g ($) | 0.032 | 0.031 | 0.029 | 0.028 | - | - |
| Feed cost index (FCI) | 100 | 96 | 92 | 88 | - | - |
| Feed cost/ 100 g wt. gain ($) | 0.11 | 0.12 | 0.13 | 0.11 | 0.04 | 0.460 |

*Weight of internal organs*

Table 4 indicates the absolute and relative weight of the internal organs of the rats. Except for the relative weight of empty GIT where rats on treatment T3 recorded a higher ($P$ <0.05) weight compared to rats on the other treatments, no differences ($P$ > 0.05) were observed for all other carcass traits measured. Diet T3 had the highest crude fibre percent (i.e. 4.89%) and that could have significantly influenced the relative weight of empty GIT. Several scientists have indicated that pigs fed high-fibre diets resulted in heavier weights of GIT than their counterparts given low-fibre diets (Len *et al*., 2009; Freire *et al*., 2003). However, the higher value for the T3 rats for empty GIT is still within the normal ranges of values for both absolute and relative values as stated by NBRP (2017). Furthermore, these results (Table 4) corroborate the finding of Donkoh *et al.* (2012) who reported no difference ($P$ > 0.05) in the intestinal weights of laboratory rat fed dried cashew nut testa.

TABLE 4

*Absolute and relative weight of internal organs of rats fed diets containing varying levels of DCAM*

| *Absolute weight (g)* | Dietary treatments T0 | T1 | T2 | T3 | SEM | F pr. |
|---|---|---|---|---|---|---|
| Viscera | 32.0 | 31.1 | 32.6 | 30.2 | 2.23 | 0.873 |
| Full GIT | 18.1 | 18.3 | 18.6 | 16.4 | 1.33 | 0.661 |
| Empty GIT | 9.57 | 8.99 | 10.54 | 8.95 | 0.57 | 0.236 |
| Kidney | 1.39 | 1.21 | 1.27 | 1.27 | 0.09 | 0.582 |
| Heart | 0.64 | 0.57 | 0.55 | 0.58 | 0.04 | 0.386 |
| Liver | 8.07 | 7.46 | 8.28 | 8.14 | 0.60 | 0.783 |
| Respiratory Tract | 1.78 | 1.64 | 1.54 | 1.38 | 0.14 | 0.285 |
| Spleen | 0.80 | 0.55 | 0.91 | 0.73 | 0.17 | 0.526 |
| Empty Stomach | 1.12 | 1.02 | 1.13 | 1.05 | 0.07 | 0.627 |
| Full Stomach | 3.31 | 4.11 | 2.73 | 2.22 | 0.46 | 0.078 |
| *Relative weight (%)* | | | | | | |
| Viscera | 20.3 | 21.2 | 23.9 | 20.8 | 0.10 | 0.122 |
| Full GIT | 11.5 | 12.5 | 13.6 | 11.4 | 0.57 | 0.070 |
| Empty GIT | 6.09$^{a}$ | 6.17$^{a}$ | 6.18$^{a}$ | 7.64$^{b}$ | 0.22 | 0.002 |
| Kidney | 0.88 | 0.82 | 0.93 | 0.87 | 0.05 | 0.582 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Heart | 0.41 | 0.39 | 0.41 | 0.40 | 0.03 | 0.982 |
| Liver | 5.14 | 5.09 | 6.10 | 5.62 | 0.32 | 0.162 |
| Respiratory Tract | 1.13 | 1.12 | 1.11 | 0.95 | 0.10 | 0.509 |
| Spleen | 0.51 | 0.38 | 0.65 | 0.49 | 0.12 | 0.510 |
| Empty Stomach | 0.71 | 0.69 | 0.83 | 0.72 | 0.05 | 0.256 |
| Full Stomach | 2.09 | 2.81 | 1.99 | 1.54 | 0.28 | 0.065 |

[ab]Means on the same row with different superscript differs significantly ($p<0.05$)

## Conclusion

The nutrient composition of the dried cashew apple meal (DCAM) suggests that it could be an energy source in the diets of monogastric farm animals. Furthermore, DCAM could be included in the diet of a monogastric farm animal to about 15% inclusion level without any deleterious effect on growth performance and carcass traits. However, farmers should carefully assess the cost of collecting and processing cashew apples before feeding them to their animals.

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