**Review Paper:**

**Utilization and Economics of Cashew Pulp Waste as Animal Feed Stuff: A Review**

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**Abstract**

The limited supplies of raw materials for the feed industry have resulted in a continuous increase in the cost of production causing a phenomenal rise in the unit cost of products. Oladunjoye et al. stated that high cost of maize makes it difficult for farmers to afford the feedstuff and besides, the competition between man and his animals for cereals, pulses and oil seeds is partly responsible for the ever-increasing livestock feed cost. The fact that the availability of the world’s raw materials is dwindling as population grows exponentially, together with the real threat of global food shortages, contributes to growing awareness of the need for conservation and the re-use of things which once would have been thrown away without a second thought.

**Keywords:** Cashew Pulp Waste, Animal feed stuff, Nigeria.

**Introduction**

The by-products from cocoa, kola, coffee, cashew and tea, viz. spent tea leaf, cashew apple waste, cocoa leaf, coffee bean testa, coffee husk, kola testa, kola pod husk, cocoa bean shell and cocoa pod husk (constituting disposal problem at the factory site and/or farmstead in producing countries) have great potential as feed and owing to their non-consumption by humans and richness in nutritional compounds.

Oyewole et al. opined that livestock feed cost is one of those variables that have contributed to the high cost of production. The solution to this problem lies in the evaluation of alternative feed ingredients; however, such alternatives should possess nutritive value and be cheaper than the conventional protein and energy sources.

**The Nigerian Livestock Feed Crises**

There have been several attempts to reduce cost of production by replacing conventional feedstuffs with agro-industrial by-products such as maize offal, cassava peel meal and rice offal among others. Amongst these is the cashew pulp waste (CPW) which is obtained after cashew juice is squeezed from its berry, dried and milled. The availability of cashew pulp waste (CPW) in large amount in Nigeria, which is allowed to rot away yearly beside constituting environmental problem and the dearth of information on the use of cashew pulp waste as an alternative source of feedstuffs to animals necessitated this review.

<table>
<thead>
<tr>
<th>Species</th>
<th>Number (millions)</th>
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<tbody>
<tr>
<td>Chicken</td>
<td>82,400.00</td>
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<tr>
<td>Goats</td>
<td>34,500.00</td>
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<tr>
<td>Sheep</td>
<td>22,100.00</td>
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<tr>
<td>Cattle</td>
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<tr>
<td>Horses</td>
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<td>Camels</td>
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<tr>
<td>Other poultry*</td>
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<td>Pigs</td>
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<tr>
<td>Rabbits</td>
<td>1,700.00</td>
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<tr>
<td>Guinea pigs</td>
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</tr>
</tbody>
</table>

* includes pigeons, ducks, Guinea fowls and Turkeys

**Proximate Composition of Cashew Pulp and Dry Waste**

Different authors have reported the proximate composition for cashew pulp waste. Cashew apple or cashew pseudo fruits are rich source of vitamin C, organic acids, antioxidants, minerals and carbohydrates. Fanimo et al. reported that CPW contained crude protein (CP), crude fibre (CF), ether extract (EE) and ash (187) 18.7%, 84, 24 and 54g/kg DM respectively. The CP, fat, ash, CF in g kg⁻¹ DM and digestible energy contents reported by Arneh 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.

Castillo and Gerpacio also reported that fresh cashew apple contained 86.90% dry matter, 7.76% crude protein, 3.9% ether extract, 6.65% crude fibre, 3.62% ash and 64% nitrogen free extract. The dried apple contained 85.53% dry matter, 8.62% crude protein, 5.86% crude fibre, 5.86% ether extract, 2.71% ash and 60.41% nitrogen free extract. Okpanachi et al. reported the values of dry matter, crude protein, crude fibre, ether extract, ash and carbohydrate as 88.78%, 13.82%, 6.71%, 10.62%, 2.85% and 54.79% respectively for the sun-dried yellow cashew pulp meal, while dry matter, crude protein, crude fibre, ether extract, ash and carbohydrate were 89.20%, 16.96%, 7.08%, 10.41%, 2.48% and 52.28% respectively for red cashew pulp meal. The workers concluded that the red cashew variety was richer in crude protein while the yellow cashew variety was richer in carbohydrate.
Anti-nutritional Factors in Cashew Pulp Waste

Okpanachi et al\textsuperscript{30,31} reported the presence of saponin, tannin, flavonoid, phytate and oxalate in cashew pulp. Sun-dried yellow cashew pulp contained 0.1568\%, 0.0621\%, 0.0767\%, 0.3159\% and 0.0287\% saponin, tannin, flavonoid, phytate and oxalate respectively while the sun-dried red cashew pulp had 0.0701\%, 0.0877\%, 0.0438\%, 0.3661\% and 0.0327\% saponin, tannin, flavonoid, phytate and oxalate respectively.

Responses of Animals Fed Diets containing Cashew Pulp Waste

The nutritive value of dried cashew apple waste was investigated by Fanimo et al\textsuperscript{17} using growing rabbits. The rabbits were fed diets that contained 0\% (control) 10, 20 and 30\% of dried cashew apple waste. Rabbits fed diets with 20 and 30\% dried cashew apple waste gained weight (p<0.05) with increased level of dried cashew apple waste. There were no significant differences (p>0.05) in the blood metabolites except cholesterol level which increased (p<0.05) with dried cashew apple waste inclusion in the diets.

More so, 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 crude protein decreased (p<0.05) with increase in the level of cashew apple waste in the diets.

Generally, cashew apple waste increased (p<0.05) the relative weight of the carcass traits. Dried cashew apple waste was 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. 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\%.

Okpanachi et al\textsuperscript{30,31} also investigated the effect of feeding sun-dried cashew pulp-based diet on performance of West African Dwarf goat. According to the workers, 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 (T3) to 7708 g (T1). Average daily and total feed intakes ranged from 237.52 (T2) to 259.45 (T1) and 21614.00 (T2) to 23610.00 (T1) respectively. Average daily and total water intakes ranged from 330.95 (T3) to 386.07 (T1) and 25483.00 (T3) to 29726.00 (T1) respectively. Average daily body weight gain and total body weight gains ranged from 3.43 (T3) to 12.83 (T1) and 312.00 (T3) to 1168.00 (T1) respectively. The general decrease in body weight gain may be due to the health challenges faced by the goats due to season with those in T3 being the worst hit.

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 loss. 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. It was concluded that the inclusion of sun-dried cashew pulp meal up to 30\% did not adversely affect performance parameters. Okpanachi et al\textsuperscript{30,31} reported that crude fibre and ether extract were affected by the level of inclusion of sun-dried cashew pulp in West African Dwarf Goats.

Values for dry matter ranged from 91.14\% to 95.44\%, crude protein digestibility in the study was between 48.52\% to 54.99\% which reduced as the inclusion level of sun-dried cashew pulp increased. The workers suggested that the low crude protein digestibility coefficient in the study was due to the very high crude fibre in the experimental diets.

However, treatment one (T1) with the highest crude protein digestibility coefficient also has the lowest crude fibre content. The crude fibre digestibility coefficients in the study ranged from 52.32 in T3 to 61.77 in T1. The values for crude fibre in T1 and T2 were higher for other treatments. Values of ether extract digestibility in the study were fairly high ranging from 66.64 in T2 to 73.20 in T1.

The average high digestibility coefficient of most of the nutrients in the study would 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\textsuperscript{30,31}. In Brazil, dried cashew bagasse was fed to growing pigs up to 20\% dietary level.

Compared to soybean meal or sorghum, dried cashew bagasse had low protein digestibility (12\%) and low energy digestibility (23\%) which resulted in low metabolizable energy (1051 kcal/kg) and reduced metabolizable energy of the diet (3225 kcal/kg vs. 4125 kcal/kg).\textsuperscript{16,17} According to Armah\textsuperscript{16}, the level of dried cashew pulp (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 pigs whose diets contained 0, 50, 100 and 150 DCP kg\% respectively.

Oyewole et al\textsuperscript{16} reported that the inclusion of cashew pulp meal (CPM) in the diet of starter cockerel birds depressed live weight. The workers observed that birds on the control (0\%CPM) had the best daily weight gain while those on 40\%CPM inclusion had worst. However, the substitution of maize by the CPM did not affect palatability and acceptability of the diets by the birds. Feed conversion ratio (FCR) was depressed in the CPM group. It was also suggested that CPM was safe for cockerels.

Oyewole et al\textsuperscript{17} reported starter broiler as live weight of birds was highest with the control group and least with birds on 10\% CPM, indicating poor utilization by birds in this group.
Daily weight gain followed similar trend as live weight. Feed intake for all the groups was similar. The FCR was best with the control birds. In a broiler trial, cashew apple meal was included in the ration at 0, 10, 15, 20 and 25 % to replace part of maize and de-oiled rice bran. The weight gain at 8 weeks by birds on 10 % cashew apple meal diet and those on the basal diet was similar. However, with inclusion of 15 % and above, there was a progressive decrease in weight gain.

The birds retained 44.7 %, 39.9 %, 37.9 %, 33.6 % and 35.4 % nitrogen at the 0, 10, 15, 20 and 25 % levels respectively. In trial 2 cashew apple meal was included at 10 % and 15% levels and supplemented with the enzyme beta-glucanase. The weight gain of chicks on 10 % and 15 % cashew apple meal diets was comparable to the basal group. The enzyme addition marginally improved weight gain. The feed intake was higher resulting in poor feed efficiency, but the incidence of severe pasted vents was reduced. In broilers, the addition of 5% to 15% dehydrated cashew bagasse in the diets did not significantly affect growth performance, but feed intake was increased and feed efficiency was degraded.

**Economic Importance of Cashew Pulp Waste**

Cashew apple is about 5-10 times the size of the nuts and less than 10% of it is utilized in Nigeria while the rest is left to rot on the farm. There has been advocacy for the development of acceptable products from cashew apple for its further utilization. Dried cashew apple pulp or waste has been included in rabbit and goat feed in Nigeria without any deleterious effect by Fanimo et al and Okpanachi et al respectively. 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.

According to Oyewole et al, cost/kg feed decreased across the treatments with increase in the rate of inclusion of cashew pulp meal (CPM) in maize based control diet. The workers attributed this reduction to the cheaper cost of CPM relative to maize. Cost of feed/kg gain was best with birds on 30%CPM and worst with those on 10%CPM. Hence the most economic diet was 30%CPM while those birds fed with 10%CPM poorest.

Oyewole et al had also reported that the increasing CPM in the diets of starter broilers resulted in progressive reduction in the cost of feed. Cost of feed/kg gain was best with birds on 20% CPM and worst with those on 10% CPM. Liwayway et al reported that higher net income was obtained for pigs on 20% dried cashew apple followed by fatteners fed with 20% fresh cashew apple.

Least net income was obtained from the control. Feed cost per diet decreased by incorporating dried cashew apple in the ration. The workers concluded that fresh cashew apple and dried cashew apple can be fed to hogs from 20% in the ration as the cost of production is reduced by using either fresh or dried cashew apple mixed with other feed ingredients in the ration for fattening hogs.

**Safety of Feeding Animals Diets containing Cashew Pulp Waste**

Oyewole et al reported that asparte transaminase (AST), alanine transaminase (ALT), total protein and creatinine values were significantly (< 0.05) influenced by the treatments. The workers indicated that the trend of results observed for both AST and ALT suggested that the birds did not experience hepatic or renal damage due to the diets. The observed total protein values indicated that the protein quality and quantity of each of the diets were adequate. CPM at 5 or 10% had similar total protein as the control, an indication that the inclusion of CPM in the diets did not compromise protein quality and quantity. It has been observed that serum urea and total protein contents also depend on quality and quantity of the protein supplied in the diet. Serum urea was observed to be similar for all the dietary groups.

According to the workers, observed albumin values suggested good health because elevated serum albumin may indicate poor health and a predictor of a bad outcome. The workers opined that the observed values for creatinine did not suggest damage to the kidneys as the observed trend cannot be attributed to the level of CPM in the diets. Inclusion of dried cashew apple waste in rabbit diet up 30 % increased (p< 0.05) the relative weights of kidney, liver and carcass cut parts. Oyewole et al reported that the inclusion of cashew pulp meal in the diets of starter broilers had significant (P< 0.05) effect on the all haematologic parameters that were investigated. However, observed values were within ranges reported for healthy and normal birds.

**Conclusion and Recommendations**

Cashew apple waste or cashew pulp meal is safe for feeding of livestock. The availability of cashew pulp waste which is allowed to waste in Nigeria on a yearly basis is a result of high production of cashew fruit (seed). It is also obvious that to prevent this waste from constituting environmental pollution, cashew pulp waste when properly processed can be used as an alternative source of feedstuff for livestock thereby reducing the competition existing between man and his animals for conventional feedstuffs.

Hence the inclusion of cashew pulp waste as a feed stuff in the diets of poultry and other livestock should be encouraged, besides better processing of the ingredient to make improve its utilization by poultry and other livestock.

**References**


(Received 21st September 2019, accepted 26th December 2019)