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REVIEW PAPER OPEN ACCESS

Cashew in Breeding: Research synthesis

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Abstract

This review aims to show the research on the safe use of the cashew nut and its by-products in animal feed. They can replace corn and soy in animal diets. These investigations have involved chickens, rabbits, pigs, rats and cattle. Indeed, the cashew nuts and its by-products are rich in nutrients (carbohydrates, fats, minerals and proteins). They allow animals that eat them to make animal performances comparable to those obtained with corn and soybeans. The use of cashew nut and its by-products in livestock production is in addition to the nutritional, economic interest.

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Introduction

Following the high cost of breeding in developing countries, there is a compelling need to explore the possibility of using agro-industrial by products and wastes such as discarded cashew nut-waste in breeding. Of the (raw) cashew nuts being processed in many of the producing countries (Spore, 1997; Olunloyo, 1996), only about 60-65% are suitable for edible purposes while the rest are discarded as broken or scorched kernels (Fetuga *et al.*, 1974a).

To this end, several studies have been conducted around the world to show the nutritional value of cashew nut meal (Agbede, 2006; Sogunle *et al.*, 2009; Edet *et al.*, 2010), cashew apple and its by-products (Fanimo *et al.*, 2003; Ojewola *et al.* 2004; Amah, 2011) in livestock. They provide the chemical compositions of these agricultural commodities and establish their nutritional value.

This updated review of the literature that focuses on the use of cashew nut (*Anacardium occidentale*) and its by-products in food is made to promote these agricultural products to livestock.

Conservation of cashew and its by-products for animal feed

In China, a pilot-scale conservation of cashew apple fruit was conducted with 5 treatments: cashew apple fruit alone, 90% cashew apple fruit + 10% rice bran, 95% cashew apple fruit + 5% paddy straw, 90% cashew apple fruit + 10% cassava peelings and 70% cashew apple fruit + 30% cassava waste (Baph, 1996). After conservation, an experiment on 40 animals was conducted under complete randomized block design with five groups of 8 animals each. It is concluded that, the mixtures of 10% rice bran or with 10% cassava peelings are better and appropriate in making conservation of cashew apple for long time. Rice bran, cassava peelings, cassava waste and paddy straw could be used for the conservation of fresh cashew apple. The best results could be obtained with rice bran 10%, cassava peelings 10%. The mixtures with cassava waste 30% and paddy straw 5% were also acceptable (Baph, 1996).

Also in India, a study was conducted to examine the possibility of using whole cashew apple and cashew apple waste (after juice extraction) as feed for dairy cows by ensiling them with poultry litter (Kinh et al., 1996). Four treatments (combinations with poultry litter) with each product were compared as follows: 100% cashew apple waste or cashew apple , 90% cashew apple waste (or cashew apple) + 10% poultry litter , 80% cashew apple waste (or cashew apple) + 20% poultry litter and 70% cashew apple waste (or cashew apple) + 30% poultry litter based on fresh weight. The materials were ensiled in glass jars (2.5 liters capacity). Each treatment lasted 0, 3, 7, 15 and 30 days after ensiling. It is concluded that cashew apple fruit and cashew apple waste can be preserved for long term use by anaerobic ensiling and that there appeared to be little advantage in mixing them with poultry litter before ensiling. The conversion of the soluble sugars into organic acids and alcohol may have negative effects on nutritive value. Feeding trials are necessary to evaluate this (Kinh *et al.*, 1996). According to Stamford *et al.*, (1988) sun-drying was the most adequate treatment for cashew waste flour.

Composition of cashew nut, pseudo fruit of cashew (pulp of cashew)

Several researchers have determined the chemical composition of cashew nut and its by-products. The tables 1 show the composition of cashew nut (Ojewola et al., 2004; Usda, 2004). Chemical analysis has shown that cashew nut meal extracted from whole kernels contains about 42% crude protein, about 1% crude lipid, a low content of crude fiber and 0.5 and 0.2% calcium and phosphorus, respectively. The meal has good quality protein containing 4.6% lysine, 1.3 % tryptophan, about 2% cystine and 1.6 % methionine. Methionine, tyrosine, and valine were the limiting amino acids of cashew waste flour and contents of the

other amino acids, especially lysine, were relatively high (Stamford et al., 1988). The content of sulphur-containing amino acids is higher than that of soybean and groundnut meals. The meal from cashew nut is shown to be superior to that of soybean meal, judging from the weight gains obtained and 'protein score' calculated at 97 for cashew and 93 for soyabean meal (Piva et al., 1971). Given the chemical composition and organoleptic characteristics of the sun-dried flour of cashew waste; this product can be used for animal consumption (Stamford *et al*., 1988).

Table 1.1. Composition of cashew nut meal.

Proximate fraction	Percentage (%)
Crude protein	38.12
Crude fat (Ether extract)	16.10
Crude fiber	0.72
Ash	5.21
Dry matter (DM)	91.43
Moisture	8.57
Calcium	0.06
Phosphorus	1.69
Magnesium	0.41
Sodium	0.05
Potassium	0.15

Adapted from Ojewola *et al*. (2004)

Apart from Cu and Co, which was not detected, cashew nut meal contained appreciable nutritionally needed mineral elements: P, Ca, Mg, K, Na, Zn and Fe. They were higher in most cases in defatted than in the defatted samples (Aletor et al., 2007). Roasted cashew nuts have been shown to contain less toxicant including chellators of bone minerals (Edet, 2007).

Other analytical data indicate that the good and rejected cashew nut could be important alternative protein (whole cashew nut meal: 34%; defatting rejected cashew nut: 45.5%) and energy contributors to compound non ruminant animal feed in this region (Aletor *et al*., 2007). Cashew apple or cashew pseudo fruits (*Anacardium occidentale* L.) are rich source of vitamin C, organic acids, antioxidants, minerals and carbohydrates (Sivagurunathan *et al*., 2010).

The functional properties of roasted and defatted cashew nut (*Anarcadium occidentale*) meal (Table 2) were determined by Omosulis *et al*. (2011). They concluded that the great properties of this meal showed that it could be used as a thicker in food systems, binder in meat emulsion and in the colloidal food systems as emulsion stabilizer (Omosulis *et al*., 2011).

Nutritional value of cashew nut, cashew apple fruit and by products in chicks, pullet and finishing broiler chickens

The feeding value of cashew apple (*Anacardium occidentale* L.) meal to broiler chicks was assessed in two trials. In trial 1 cashew apple meal was included in the ration at 0, 10, 15, 20 and 25 % replacing part of maize and de-oiled rice bran. The weight gain at 8 weeks on 10 % cashew apple meal diet and on the basal diet was similar (Kardivel *et al*., 1993). 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 of cashew apple meal in the diet, respectively. The cashew apple meal fed birds had a higher incidence of performance. 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 (Kardivel *et al*., 1993).

Babajide (1998) reported no negative effect of cashew kernel meal on broiler performance and carcass quality indices. This non-conventional feeding resource may be a viable alternative for achieving optimum performance and curtailing production costs that is presently the bane of poultry production in the developing countries. Pre and early laying performances of pullets were therefore used as

measures of response (Odunsi, 2002). In conclusion, the current findings indicate that reject cashew kernel meal is low in protein but high in energy compared to groundnut cake.

Table 1.2. Nutrient in 100 g of cashew nut.

Nutrient	Unit	Value
Calories	Kcal	570
Protein	g	15
Total Fat	g	46
Saturated Fat	g	9
Monounsaturated Fat	g	27
Polyunsaturated Fat	g	8
Linoleic acid (18.2)	g	7.66
Linolenic acid (18.3)	g	0.16
Carbohydrate	g	33
Fiber	g	3

Adapted from Usda (2004)

Table 1.3. Phytosterols content in 100 g of cashew nut.

Nutrient	Unit	Value
Total Phytosterols	mg	158
Lutein + Zeaxanthin	mg	23

Adapted from Usda (2004)

The effect of feeding reject cashew kernel meal on pre and early laying performance of pullet was investigated. Cashew kernel meal was incorporated into a standard grower diet at 0, 5, 10, 15 and 20 % replacing parts of maize and groundnut cake. Each diet was offered to 18 black Harco grower pullets (12 weeks old) for a period of 8 weeks, after which they were fed on a layer dietary regime containing similar levels of cashew kernel meal for another 8 weeks. Results indicated that up to 20 weeks, pullets on 0% reject cashew kernel meal had a non significantly higher feed intake, poorer feed efficiency and higher feed cost than reject cashew kernel meal based diets (Odunsi, 2002). Onset of laying was, however, slightly delayed with increasing reject cashew kernel meal in diets. Between 21-28 weeks, feed intake was markedly ($p>0.05$) affected by inclusion of reject cashew kernel meal while hen day production, feed efficiency and egg quality values were unaffected ($p<0.05$). Reject cashew kernel meal at the levels studied appears a justifiable alternative to maize and groundnut cake in pullet diets (Odunsi, 2002).

Table 1.4. Minerals content in 100 g of cashew nut.

Nutrient	Unit	Value
Calcium	mg	45
Iron	mg	6.00
Magnesium	mg	260
Phosphorus	mg	490
Potasium	mg	565
Sodium	mg	16
Zinc	mg	5.60
Copper	mg	2.22
Manganese	mg	0.83
Selenium	mg	11.70

Adapted from Usda (2004)

In a study done by Ojewola et al. (2004), cashew nut meal was substituted for soybean meal at 0, 25, 50, 75 and 100% and the diets were respectively designated as diets 1, 2, 3, 4 and 5 in a completely randomized design. Body weight changes, feed intake, feed-to-gain ratio and the economics of production were investigated in finishing broiler chickens. The feed-to-gain ratio was significantly ($p<0.05$) influenced while other parameters were not (Ojewola *et al.*, 2004). Diet 3, containing 50 %, gave cashew nut meal the best value (2.24) followed closely by diets 4 (2.25) and 2 (2.28) respectively, while diet 1 had the poorest value (2.53) followed by diet 5 (2.40). The mean daily feed intake numerically improved as the percent cashew nut meal substitution increased from 0 to 100%. Birds fed diet 4 had the highest value (120.58 g) while birds fed diet 1 had the least value (115.84 g) (Ojewola *et al.*, 2004). The mean total body weight gain (g) was highest (2214 g) for birds fed diet 3 while birds fed diet 1 had the least value (1878.00 g). The cost/kg diet (Naira) decreased as the dietary inclusion of the test ingredient increased from 0 to 100%. At the end of the trial, the highest marginal revenue was obtained from birds fed diet 4 (Naira 415.32). This was closely followed by birds fed diets 3, 5, 2 and 1. Cashew nut meal is therefore recommended as a substitute for the expensive conventional plant proteins at 25, 50 and 75 % levels (Ojewola *et al.*, 2004).This agrees with the

report of Agbede (2006), that soybean meal in broiler finisher diets could be replaced up to 50 % with discarded cashew nut-waste.

Table 1.5. Vitamins content in 100 g of cashew nut.

Nutrient	Unit	Value
Thiamin	mg	0.20
Riboflavin	mg	0.20
Niacin	mg	1.40
Pantothenic acid	mg	1.22
Vitamin B6	mg	0.26
Folate	mg	69
Vitamin K	mg	34.70
Tocopherol, alpha	mg	0.92

Adapted from Usda (2004)

The performance of growing pullets fed cassava (*Manihot esculenta Crantz*) peel meal diet supplemented with cashew nut (*Anacardium occidentale* L) reject meal were studied for 13 weeks using four hundred and thirty-two (9 weeks old) Yaafa Brown pullet chicks. The birds were maintained on a grower diet consisting of 3 levels of cassava peel meal (0, 10 and 20 %) each supplemented with 4 levels of cashew nut reject meal (0, 10, 20 and 30 %). The highest weight gain of 7.96 g/bird/day was obtained in diet 3 (0% cassava peel meal and 20 % cashew nut reject meal) while the highest feed intake of 107.29 g/bird/day and cost of 1 kg feed of $0.31 were obtained in diet 12 (20 % cassava peel meal and 30 % cashew nut reject meal) (Sogunle *et al*., 2009).

Table 2. Functional properties of roasted and defatted cashew nut meal

Functional properties	Value
Water Absorption capacity (%)	240.0 ± 0.3
Emulsion capacity (%)	45.5 ± 0.2
Emulsion stability (%)	54.2 ± 0.3
Foaming capacity (%)	12.0 ± 0.1
Oil Absorption capacity (%)	220.0 ± 0.2
Foaming stability (%)	6.7 ± 0.2
Least gelation concentration (%)	8.0 ± 0.1
Bulk density (gml-l)	0.73 ± 0.2

Adapted from Omosulis *et al.* (2011)

The growing pullets performed poorly with increasing cassava peel meal in the diets but had an improved performance, as cashew nut reject meal was included. It was then concluded that the combination of 10% cassava peel meal and 30% cashew nut reject meal was appropriate for enhanced performance of growing pullets (Sogunle et al., 2009).

In growing rabbits

The nutritive value of dried cashew apple waste was investigated equally by Fanimo *et al.* (2003). 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 dried cashew apple waste. Thirty six (6-week old) rabbits were fed these diets and growth performance was recorded. Fecal apparent digestibility of nutrients was measured in 12 rabbits. Rabbits fed diets with 20 and 30 % dried cashew apple waste gained weight ($p<0.05$) faster than those fed the control diet. Feed efficiency increased with levels of dried cashew apple waste in the diets with rabbits on 30 % dried cashew apple waste being most efficient. Crude protein digestibility decreased ($p< 0.05$) 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. It is inferred that dried cashew apple waste can be included in growing rabbit diets up to 30% of the dry matter (Fanimo *et al*., 2003).

In cattle

Cattle were fed a basal diet containing rice straw and cassava waste and each group was fed with experimental diet corresponding to above five treatments. Results showed that the quality of conserved feed was similar to those obtained in laboratory, in which, cashew apple fruit with rice bran and with cassava peelings were better than other treatments (90 and 88 marks, respectively). Feed intake and average daily gain of these two groups were also higher (7.92 and 5.87kg/head and 259 and 236 g/head/day, respectively, ($p<0.05$) followed by group

fed cashew apple fruit with cassava waste (5.63 kg/head and 228 g/head/day) (Kardivel, 1993).

In growing pigs

Fetuga et al. (1974b) showed that when discarded cashew nut meal was evaluated at a critical protein level with growing pigs, it demonstrated superiority to groundnut cake or soybean meal. In Ghana, dried cashew pulp was investigated for its nutritional quality. The dried cashew pulp was obtained from Cocoa Research Institute of Ghana. The crude protein, fat, ash, crude fiber in g kg-1 of dry matter and digestible energy contents were 86.0, 99.6, 38.0, 116.0 and 14.38 MJ, respectively (Armah, 2011). In a subsequent feeding trial, twelve Large White starter pigs with an average initial weight of 13.3 kg were randomly allotted into four groups in a completely randomized design and fed diets containing 0, 50, 100 and 150 g dried cashew pulp kg-1 to determine growth performance and carcass characteristics. Water and feed were provided *ad-libitum*. The level of dried cashew pulp had no significant ($p>0.05$) effect on feed intake but had a significant ($p < 0.05$) effect on weight gain. Final live weights were 58.67, 53.0, 59.67 and 48.67 kg for pig's diets containing 0, 50, 100 and 150 dried cashew pulp g kg-1 respectively. Furthermore the dietary treatments did not have significant ($p>0.05$) impact on the various carcass traits, except ham weight. Feed cost per diet decreased with increasing dried cashew pulp levels. The cost of feed to produce a kg weight gain was lowest for the diet containing the 100 g dried cashew pulp kg-1. It was concluded that up to 100 g dried cashew pulp 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 dried cashew pulp is possible (Armah, 2011).

In rats

Piva et al. (1971) further observed that young growing rats fed cashew nut meal had higher weight gains and protein efficiency ratio than those fed soybean meal or casein. Evaluation of the protein quality of raw and roasted cashew nuts (*Anacardium occidentale*) yellow apple variety, using weanling albino rats showed that feeding the animals with the raw cashew nut based diet resulted in reduced weight gain (2.75±0.31g) nitrogen balance (NB) (2.22 ± 0.11%), protein efficiency ratio (PER) (2.37± 0.38%), gross protein digestibility (GPD) (57.00 ± 0.21 %), net protein utilization (NPU) (42,77 ± 0,23%), total protein digestibility (TPD) (63.30 ± 0.20 %) and biological value (VB) (58,00 ± 0,11 %). Roasting resulted in higher weight gain (3.68 ± 0.19 g), NB (3.16 ± 0.13 %), GPD (66.0 ± 0.14 %), NPU (60.98 ± 0.20 %), TPD (71.00 ± 0.13 %), BV (76.00 ± 0.10 %) and PER (2.87 ± 0.26 %). Hence roasting is adjudged the better alternative of cashew nuts; preparation for use in animal feed formulation (Edet *et al*., 2010).

Risks Related to the consumption of cashew, cashew fruit and its by-products

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). According to Agbede and Aletor (2003), the hematological variables of birds fed with the control diet soybean meal and those fed with the test diets containing discarded cashew nut-waste were not significantly ($p<0.05$) affected by the dietary treatment. This suggests that the replacement of soybean meal with discarded cashew nut-waste did not have adverse effect on the hematological variables in the chicks. 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 (Fanimo *et al*., 2003).

The effects of sub-chronically administered extract on hepatocytes were minimal as the serum alkaline phosphatase; total bilirubin and total protein levels in treated animals were not significant ($p< 0.05$). Thus, sub-chronic administrations of *Anacardium occidentale* inner stem bark extract did not

significantly ($p<0.05$) depress the function of hepatocytes in Wistar rats (Okonkwo *et al*., 2010).

In his study, Armah (2011) found in pigs that there were no health-related problems or deaths that could be attributed to the inclusion of dried cashew pulp in the diet.

Conclusion

Ultimately, it is determined that the cashew nut and its by-products can be used in animal feed without affecting their health. Indeed, these agricultural products are rich in nutrients- 15 to 38 % protein, 33% carbohydrate and 46 % fat- and have large amounts of major minerals (Ca, K, Na and P) and vitamins (thiamine, niacin, vitamins B6 and K). Tested in chickens, rabbits, pigs, cattle, cashew flour and its by-products allowed them to achieve animal performance comparable to those obtained with conventional grain products.

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