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Effects of Dried Edible Cashew (Anacardium Occidentale) Apple on the Performance and Economics of Production of Grower Dutch Rabbits

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ABSTRACT

Dried edible cashew apple, grinded into powder was substituted for groundnut cake at four levels (0,10,20 and 30%) to formulate four experimental diets (1,2,3 and 4), in which A is the control diet. 40 mixed sexes of Dutch rabbits were randomly allocated into four groups each with three replicates in a completely randomized design. These were fed experimental diets for a period of eighty-four days. Its nutritive and cost effectiveness of the feeds were assessed at the end of the feeding period. Live weight gain of rabbits increased corresponding with increasing inclusion of cashew apple bagasse. There was no significant difference (P>0.05) in the mean weight gain of rabbits fed diets 3 and 1(Control diet). Feed conversion ratios were also observed to be similar among diets 1 to 3, while that of diet 4 decreased significantly from 1 (control). However, both cost/kg of feed produced and cost of feed consumed per weight gain decreased correspondingly as more of the substitution was made, indicating a profitable and worthwhile study. Cost per feed intake and cost/g weight gain were significantly lowered (P>0.05) as dried edible cashew apple meal increases in the diets. In summary, a good economic return is possible if this cashew waste can be processed into rabbit diet (particularly for weaners and grower production).

Keywords: *Dried Edible Cashew Apple, Groundnut Cake, Dutch Rabbits Diets, Cost Effectiveness*

INTRODUCTION

The recent high costs of feed ingredients in particular have brought about the need to look inwards for alternative to the conventional feed resources. It is therefore imperative to explore other feed materials that are not useful to human (Ahaotu *et al*., 2013a). 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 (Aletor *et al*., 2007). The increase in the cost of grains in Nigeria has been related to its scarcity as a result of competing for these feed ingredients. To depend on alternative sources of ingredients, especially when it encouraged a shift to ingredients, for which there is less competition, may help if the later is sufficiently available (Onu *et al*., 2013). Ahaotu and Onu (2013) suggested that the best logical solution to Nigeria's national meat scarcity is to increase rabbit production. In an effort to reduce the cost of rabbit production, rabbit nutritionists have tried to harness and utilize by-products and wastes that are not directly utilized by man. The use of dried edible cashew apple in rabbit has been limited because of possible deleterious effect resulting from the presence of *saponins, tannins,glucosinolates* and *phenolic* compounds (Armah, 2011). *Tannins* exist in the cashew pulp or apple in two forms, (a)"Free or active *tannins*" which impart a strong bitter taste and(b) "*bound tannins*" or "vegetable *tannates*" which are insoluble, supposedly inert and which have little or no effect on palatability (Onyekwere *et al*., 2011).

One major constraint in the use of non-conventional feedstuffs is the anti-nutritional factors contained in them. Anti-nutritional factors may be defined as the chemical constituent of a feedstuff, which interferes in the normal digestion, absorption and metabolism of feeds, some of which may have deleterious effects on the animal's digestive system. Some inherent chemical constituents present in different kinds of feedstuffs interfere in the optimum utilization of nutrients and some are also toxic in high concentrations. Although anti-nutritional factors are present in many conventional feeds, these are more common in most of the non-conventional feeds (Ahaotu *et al.,* 2013b). These anti-nutritional factors need to be removed or inactivated by various procedures before the use of the ingredients in the diet (Onu *et al*., 2008).

Its utilization as an animal feed will minimize the pollution problem as well as serve as a cheap source of nutrients for the livestock and poultry industries (Ahaotu *et al.*, 2008). Cashew has been widely used as an internal and external antiseptic against bacterial infections, heal stomach ulcers of all kinds, for ear and eye infections, to stop bleeding, and heal wounds. It is also rich in minerals and vitamins. The pulp that forms about 90 % of the fruit is of high economic value, has a pleasant flavor and aroma and can be processed into a variety of suitable products such as alcoholic and non-alcoholic drinks (FAO, 2000).

The cashew tree (*Anacardium occidentale*) is a medium-sized tropical tree mainly cultivated for its fruit (cashew nut) and pseudo-fruit (cashew apple). It is also a multipurpose species that provides a broad range of services. The pseudo-fruit, the large pulpy and juicy part, has a fine sweet flavor and is commonly referred to as the "cashew fruit" or the "cashew apple". In addition to being delicious, the cashew fruit is a rich source of vitamins, minerals and other essential nutrients. It has up to five times more vitamin C than oranges and contains a high amount of mineral salts. Volatile compounds present in the fruit include esters, terpenes, and carboxylic acids (Bi-Calho, 2001) About 30-40% cashew kernels are discarded during the process of roasting and are then fed to livestock (Fanimo *et al.,* 2003). The cashew tree is a spreading, low-branched, evergreen, medium-sized tree. It can grow to a height of 6-12 m.

A wide array of industrial by-products and agricultural wastes exist, among which is cashew pulp or apple. Studies in the utilization of agro-industrial by- products in animal feed has increased in the past two decades because of the clear necessity to conserve these ingredients for human feeding especially in the less developed countries. There is also increasing knowledge of the problems created in the environment by disposing these by-products and agricultural wastes. The rational use of these nutritive diets for animal production can reduce the high price of feedstuffs.

The objectives of viewed in this study were to determine the effects of including graded levels of DCA in diets on the growth performance and carcass characteristics of grower rabbits, to assess the profitability of partially substituting maize with DCA in the rations of the starter-grower rabbits and to evaluate the nutritive value of Dried Cashew Apple as an energy supplement for rabbits. The high cost of production of rabbit products and the consequent scarcity of high cost of rabbit meat result mainly from feed scarcity. Maize, the major source of energy has become so expensive in recent times due to severe competition over the product as staple human food and raw materials for other livestock feed mills. Furthermore, there is also a need to shift emphasis from other conventional animal species to rabbits in order to explore their relative position in the overall animals industry. Agro-industrial by-products contain some fiber.

Rabbit is known for its ability to digest fiber efficiently (Mbaegbu, 2012). A statement on food consumed and product obtained should provide basic data in evaluating rations for farm animals (Anucha and Egbunwoke, 2012). Feed conversion ratio (FCR) is an important performance index in animal production. It is the expression of the quantity of feed consumed to obtain a unit of the products. Feeds and feeding constitute about 70-80% production cost in poultry. The cost of food consumed to obtain a unit of products should therefore form a basis for recommending feeds to farmers (Alawa and Oyarole, 2004). In the present study, the economics of substituting dried cashew apple meal (DCAM) for maize grain (MG) in rabbit diets was investigated.

Table1. *Food Value (Per 100 g) of fresh cashew apple*

Moisture	84.4-88.7 g
Protein	0.101-0.162 g
Fat	0.05-0.50 g
Carbohydrates	9.08-9.75 g
Fiber	0.4-1.0 g
Ash	0.19-0.34 g
Calcium	0.9-5.4 mg
Phosphorus	6.1-21.4 mg
Iron	0.19-0.71 mg

Carotene	0.03-0.742 mg
Thiamine	0.023-0.03 mg
Riboflavin	0.13-0.4 mg
Niacin	0.13-0.539 mg
Ascorbic Acid	146.6-372.0 mg

The main chemicals found in the cashew fruit are alanine, alpha-catechin, alpha-linolenic acid, anacardic acids, anacardol, antimony, arabinose, caprylic acid, cardanol, cardol, europium, folacin, gadoleic acid, gallic acid, gingkol, glucuronic acid, glutamic acid, hafnium, hexanal, histidine, hydroxybenzoic acid, isoleucine, kaempferols, L-epicatechin, lauric acid, leucine, leucocyanidin, leucopelargonidine, limonene, linoleic acid, methylglucuronic acid, myristic acid, naringenin, oleic acid, oxalic acid, palmitic acid, palmitoleic acid, phenylalanine, phytosterols, proline, quercetin-glycoside, salicylic acid, samarium, scandium, serine, squalene, stearic acid, tannin, and trans-hex-2-enal tryptophan (Kankam-Boadu, 2000).

Chemical Composition of Dried Cashew Pulp

The chemical composition of DCA is shown in Table 2 along with data on maize which it replaced in the experimental diets, for comparison.

Table2. *Chemical composition of DCP and maize (g kg-1 DM)*

Component	DCP1	Maize	DCP : Maize
Proximate composition			
Dry matter	810	887.5*	0.91
Crude Protein	86.0	89.2*	0.96
Ether extract	99.6	44.8*	2.22
Crude fibre	38.0	19.3*	2.00
Ash	38.0	19.0*	2.00
Nitrogen-free extractives	660.4	715.2*	0.92
Fibre Component			
Acid detergent fibre	121.7	32.3	3.77
Neutral detergent fibre	206.8	108.4	1.90
Hemicellulose	85.1	62.5	1.36
Mineral elements			
Calcium	7.2	0.3	24.0
Phosphorus	6.0	2.8	2.14
Potassium	16.5	3.3	5.00
Sodium	5.6	0.1	56.00
Digestible energy (MJ kg-1 DM)2	14.0	13.7	1.02

MATERIALS AND METHODS

Location of Study Area

The study was conducted at the Rabbi try Unit of Imo State Polytechnic Umuagwo. Imo State Polytechnic Umuagwo is located at The site is situated between longitudes 7^o 0^1 06^{11}E and 7^o 03^1 00^{11} and latitudes 5^o28^1 00^{11}N and 5^o 30^1 00^{11}N in the humid tropical West Africa (IMLS, 2010).The climate is marked by two seasons.

Sources of Cashew Apple (Ca) and Processing Method

The cashew apple to be used in this study was obtained from the market women from Owerri, Imo State. Freshly harvested cashew apple was carefully selected by hand-picking them from under cashew plantation. Nuts were removed from the fruits and juice was extracted with a manually operated cashew juice extractor. This was then spread thinly on a concrete slab to sundry for about a week to reduce moisture content to be less than 7%. This was because the fresh apple easily goes rancid if allowed to stay beyond a day or few hours after senescence. This dry apple bagasse was milled into fine powder, packaged and stored in an air-tight polythene bag. This powdered test ingredient was mixed in calculated proportions with other feed ingredients to formulate four experimental diets for the feed trial.

Crude lipid was extracted by ether extraction, Ash content was carried out by ashing in a Muffle furnace at 55^0C. Moisture content was determined by oven dying to a constant weight at 85^0C, while crude fiber was done by acid based digestion method (Edet, 2007). The processing done involved sun-drying, during which the sliced apples were constantly turned over. They were dried to a moisture content of about 15%,then ground in a hammer mill to produce the meal which was then be stored in polythene sacks until used. The contents of all sacks were thoroughly mixed and about 1 kg of the bulked sample was then be taken and stored in an air-tight bottle for chemical analysis.

Chemical Analyses

Proximate analyses of DCA (Dried Cashew

Apple) and experimental diets were carried out using the standard procedures of the Association of Official Analytical Chemists (2001). Acid detergent fiber (ADF), neutral detergent fiber (NDF) and hemi cellulose was also estimated based on the DCP samples.

Experimental Animals

Thirty six (36) entire mixed sexes of Dutch rabbits with a mean initial live-weight of 2.5 kg were used in the study. All animals were deformed with Levamiosol prior to the start of the experiment and at monthly intervals thereafter. The rabbits were divided into four treatments in four different hutches and were replicated three times. Each treatment of 9 rabbits were randomly allocated to one of four dietary treatments based on maize but in which DCA replaced equivalent amounts of maize (0, 50, 100, 150 g/kg). Animals in the treatments were balanced for litter origin and weights. Rabbits were kept in hutches to facilitate feeding, collection of left-over feed and observation. Rabbits were fed at 5% of body weight daily throughout the trial period. All the diets were offered to the animals in weighed quantities once daily

Table3.*Composition of Experimental Diets*

	Treatments			
Ingredients, (g kg-1)	**T_1(0 g kg-1 DCP)**	**T_2 (50 g kg-1 DCP)**	**T_3(100g kg-1 DCP)**	**T_4(150 g kg-1 DCP)**
Maize	590	560	500	450
Dried cashew apple	0	50	100	150
Fishmeal	100	100	100	100
Wheat bran	160	140	150	150
Palm kernel cake	50	50	50	50
Soybean meal	80	80	80	80
Groundnut skins	10	10	10	10
Oyster shell	5	5	5	5
Common salt	2.5	2.5	2.5	2.5
Vitamin/trace-mineral premix	2.5	2.5	2.5	2.5
Calculated Chemical analysis (gkg-1DM)				
Crude Protein	188.5	186.3	186.9	185.5
Crude Fibre	51.7	56.0	60.4	64.7
Ether Extract	38.1	41.4	44.7	48.0
Calcium	6.4	6.5	6.6	6.7
Phosphorus	6.7	6.7	6.6	6.5
DE (MJ kg-1)	14.0	14.2	14.3	14.4

At 08:00 hours throughout the trial period. Animals had free access to water. Left-over feed were collected and the weight recorded. Rabbits were weighed every week and the level of feeding was adjusted accordingly.

The performance of the animals was monitored in terms of feed consumption, weight gain and feed: gain ratio throughout the 116-day trial period. Economics of production was also computed.

Economics of production was estimated based on the feed cost per kg diet and feed cost per kg weight gain. Feed cost per kg for each of the experimental diets was estimated based on the prices of the ingredients at the time of the trial. Feed cost per kg live weight gain was also calculated for the four dietary treatments as a product of the feed cost and the feed conversion efficiency.

Data collected were subjected to analysis of variance using Steel and Torrie, (1980). Differences among means were determined by the least significant difference (LSD) method (Gordon and Gordon, 2004).

RESULTS

Performance Characteristics

The chemical composition of dried cashew apple is shown in Table 2 while the nutrient composition of the experimental diets is shown in Table 3. Data on performance and economics of production of weaner rabbits on the various dietary levels of dried cashew apple are respectively presented in Table 4 and 5.

Table 4. *Feed intake, body weight gain and feed efficiency of Grower Dutch Rabbits fed varying levels of Dried Cashew Apple*

Performance index	T_1	T_2	T_3	T_4	SEM
Initial body weight (g)	321.67	320.67	321.33	319.331	1.00
Final body weight (g)	2200.00^a	2483.30^b	2533.30^c	2516.70^c	6.44
Total weight gain (g)	1878.00^a	2162.70^b	2214.00^b	2196.70^b	6.43
Daily weight gain (g)					
(g/rabbit/day)	45.79	52.75	54.00	53.59	1.52
Daily feed intake					
(g/rabbit/day)	115.84	118.23	120.00	120.28	1.61
Total feed intake (g)	4708.3	4847.6	4919.90	4943.7	6.96
Feed-to-gain ratio	2.53^a	2.28^b	2.24^b	2.25^b	0.04

ab Means is a row, with different superscripts are significantly different ($p < 0.05$).

Table5. *Economics ofProduction ofGrower Dutch Rabbits fed varying levels of Dried Cashew Apple*

Performance index	T1	T2	T3	T4	SEM
Cost/kg feed (N)	61.95^a	58.87^b	55.80^c	52.72^d	0.02
Cost of total feed					
Intake/rabbit (N)	291.67^a	285.40^b	274.53^{ab}	260.65^{bc}	3.67
Amount realized					
(N)/rabbit (N268/kg)	590.92	667.02	680.45	675.98	4.77
Marginal revenue					
perrabbit (N)	299.26^b	361.63^{ab}	405.93^a	415.35^a	3.86

abc Means in a row with different superscripts are significantly different ($p = 0.05$).

Performance of Grower Dutch Rabbits on the different levels of dried cashew apple is presented in Table 4. Among the various parameters considered only the feed-to-gain ratio was significantly different ($p<0.05$) among the treatments. The feed-to-gain ratio for Grower Dutch rabbits fed diets 2, 3 and 4 were significantly ($p<0.05$) improved and comparable. Rabbits fed diets 1 (2.53) and 4 (2.97) were the poorest while rabbits fed diet 3 had a numerically higher mean daily weight gain (54.00g). This was closely followed by rabbits fed diet 4 (53.59g) while those fed diet 1 had the least (45.79g).

The mean daily feed intake was numerically improved as the level of substitution increased from 50% (T_2) to 100% (T_3) but slightly depressed at T_4 (150%).

Economics of Production

The cost per kg diet (N) and cost of feed consumed per rabbit (N) were significantly ($p<0.05$) reduced as the percent substitution of dried cashew apple increased from 25 to 100% in the diet thus presenting an inverse relationship with the mean cost of production (N) and marginal revenue (N). Though diets 2, 3 and 4 are comparable, diets 3 and 4 were the most economically advantageous.

Discussion

The determined nutrient content of the dried cashew apple obtained in this trial was slightly at variance with the findings of Acero *et al.*, (2013) while the mineral content was closely related to the findings of Adeyeye *et al.*, (2007). Various factors ranging from the processing method, length of storage and storage facility, the type of soil on which the crop was grown and specie differences could be responsible for such variations (Ihekoronye, 2017). The numerically higher mean daily weight gain observed for rabbits fed diets 3 could be due to the equal inclusion (50/50) of dried cashew apple.

This could have provided a positive balance of amino acid for the rabbits (Fanimo *et al.*, 2004). The associative dynamic relationship between the dietary nutrients could also have been enhanced. Fanimo *et al.*, (2003) stated that the proportion of dietary energy obtained from fats versus carbohydrates exert an effect on appetite through a physiological 'appetite control center' responsible to the blood levels of certain nutrients such as glucose and amino acids. Tuah *et al*. (2003) stated that effect of DCA might involve an increased ability of the rabbits to convert dietary energy from fat into stored energy, thereby permitting a greater increase in dietary intake.

Ranjhan (2001) observed that dietary fat did improve efficiency of feed utilization of rabbit diets and the improvement was attributed to the high energy concentration of fats, while Homer and Kazimerz (2003) attributed it to both increased density and improved Yidana (2000) suggested that fats may also increase energy utilization of other dietary constituents. The numerically higher mean daily feed intake observed for rabbits fed diets 2, 3 and 4 could be due to an improved palatability while high energy density of diet 5 could have slightly depressed appetite.

Bi-Calho (2001) said that energy rather than protein concentration seems to be the major determinant of feed intake. The values obtained for feed-to-gain ratio for rabbits fed diets 2, 3 and 4 is evidence that dried cashew appleat 25, 50 and 75% seems profitable for productive performance. Ahaotu and Mbaegbu, (2017); Edet (2007) stressed that the relative advantage or disadvantage of using any diet has to be determined by the price of the ingredients at the time of use and the current prices oflive and dressed growing rabbits in such environment.

From the result obtained, it could be observed that the rapid growth rate exhibited by rabbits fed 0, 50, 100 and 150% proved to be more economical, thus justifying the use of dried cashew applein rabbit diets.

CONCLUSION

In conclusion, the use of dried cashew apple enhanced early maturity of the rabbits and better monetary returns. Therefore, dried cashew apple could be recommended in rabbits ration at 50, 100 and 150% respectively.

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