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Effects of Partial Replacement of Dietary Maize with African Pear (*Dacryodes edulis*) Seed Meal on Performance, Nutrient Digestibility and Retention of Broiler Chickens in the Humid Tropics

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ABSTRACT

This study was aimed at determining the effects of partially replacing dietary maize with *Dacryodes edulis* seed meal on growth performance, feed consumption, mortality and nutrient digestibility and retention in broiler chickens and the cost benefit of so doing. Two hundred and 225 day old anak broilers were randomly assigned to five dietary treatments of 45 birds per treatment in which *Dacryodes edulis* Seed Meal (DESM) replaced maize at 0% (control), 15, 30, 45 and 60% levels in the diets fed at the starter (0-28 days) and finisher (29-56 days) phases of production. The birds in each treatment were further divided into three replicates of 15 birds each and provided the feed and water *ad libitum*. The performance records of the birds in terms of body weight gains and feed intake showed that while the chicks tolerated up to 60% level of maize replacement with DESM in their diets, growth in the finishing birds was significantly depressed at the upper levels of DESM inclusion. Highest mortality (11.11%) occurred only during the starter phase (0-28 days) in broilers that received 30% dietary DESM. Dry matter and crude fibre digestibility and nitrogen and fat retention generally decreased significantly with increasing levels of dietary DESM. Moreover, from an economic point of view, it was more profitable to utilize DESM at the upper levels of maize replacement (45 and 60%) in starter diets, but at not more than 30% in finisher diets.

Key words: *Dacryodes edulis*, broilers, performance, mortality, economic analysis

INTRODUCTION

Maize is conventionally used in the manufacture of commercial poultry feeds in Nigeria to provide the energy component of the feeds and usually constitutes as much as 45-60% of commercial poultry feeds in Nigeria (Bamgbose *et al*., 2004; Farinu *et al*., 1999). Its preference relative to other available grain cereals such as sorghum and millet stems from its highly digestible and palatable nature, as well as its very low tannin content. Its domestic price is, however, high because it is a staple food in Nigeria and also has a lot of industrial uses. Consequently, high costs of poultry feeds arising mainly from the high costs of conventional feed ingredients which provide the energy and protein components of the feeds continue to be the greatest cost challenge in commercial poultry enterprises in Nigeria. There is therefore an urgent need to find cheaper alternatives to maize as an energy-supplying feed ingredient especially in resource-poor countries of the tropics. In this way, the cost of finished poultry feeds can be drastically reduced and profit margins for poultry farmers increased thereby encouraging more entrepreneurs to invest in poultry production.

The African pear (*Dacreodes edulis* G. Don, H.G. Lam) is a perennial tree crop which is widely grown in the wet regions of West Africa and the Cameroons. It is highly cherished in areas where, it is grown because of its oil-rich pulp which is eaten either boiled or roasted by the local population and because of its huge economic value and medicinal properties (Koudou *et al*., 2008; Ajibesin, 2011). The seeds, which are usually discarded, are known to contain high amounts of soluble carbohydrates and lipids (Obasi and Okolie, 1993; Ajayi and Oderinde, 2002; Bratte *et al*., 2010). They therefore hold some promise as a possible cheaper alternative to maize, since they are not consumed by man as food, have very little content of anti-nutritional factors and are currently not an important industrial raw material (Bratte *et al*., 2010). However, there is no published record of their use as a possible feed ingredient in poultry diets.

This study was therefore carried out to determine the effects of partial replacement of dietary maize with graded levels of *Dacryodes edulis* Seed Meal (DESM) on the performance of broilers and the cost benefit of so doing.

MATERIALS AND METHODS

The experimental site: The study was carried out in 2005 at the Poultry Unit of the Teaching and Research Farm, Delta State University, Asaba Campus, Asaba, Nigeria, located on longitude 6° 45' E and latitude 6° 12' N. The experimental farm is situated in the Derived Savannah vegetation zone where annual rainfall ranges from 1800 to 3000 mm and the maximum day temperatures range from 27.5 to 30.9°C. The area experiences two distinct seasons: a rainy season (April to September) and a dry season (October to March).

The test ingredient: Seeds of the African pear, *Dacryodes edulis* (G. Don, H.J. Lam), which are usually discarded during the fruiting season in Nigeria, were picked up from the environment, washed in water to remove all sand particles and dehulled. The cotyledons were carefully separated by hand, sun-dried for several days until a safe moisture level of 10-13% was attained and ground with a hammer mill to obtain a flour of *Dacryodes edulis* Seed Meal (DESM).

Experimental broiler starter and broiler finisher diets: Five broiler diets in which DESM was used to replace maize at 0, 15, 30, 45 and 60% were formulated for the starter (0-28 days) and finisher (29-56 days) phases of feeding, with 0% DESM diets being the control diets. The diets were formulated with the starter diets containing approximately 2900 kcal kg^{-1} of Metabolizable Energy (ME) and 23% crude protein and the finisher diets containing approximately 3000 kcal kg^{-1} and 20% crude protein. All the diets were isocaloric and isonitrogenous and a detailed composition is presented in Table 1.

The experimental animals and their management: Two hundred and twenty-five day old anak broiler chicks were randomly allotted to five treatment groups of 45 chicks each and intensive brooded for a week. On the 8th day, the chicks in each group were divided into three replicates of 15 chicks each and brooding continued for the next 3 weeks. They were reared on deep litter, fed the experimental starter diets for the rest of the 4 week brooding period and fed the finisher diets from 5-8 weeks of age. Fresh feed and clean, cool drinking water were provided *ad libitum*. The broilers were vaccinated against *Gumboro* and *Newcastle* diseases at 2 and 3 weeks of age, respectively. Prophylactic doses of a coccidiostat, Pluricoccin ® (INVESA, Barcelona, Spain) were regularly provided in their drinking water at a dose of 1 ml L^{-1} of water. The chicks in each

Table 1: Composition of the experimental starter and finisher diets

	Levels of DESM inclusion									
	Starter (0-28 day)					Finisher (29-56 day)				
Ingredients	0%	15%	30%	45%	60%	0%	15%	30%	45%	60%
Maize	53.00	45.05	37.10	29.15	21.20	54.00	45.90	37.80	29.70	21.60
DESM[1]	0.00	7.95	15.90	23.85	31.80	0.00	8.10	16.20	24.30	32.40
Full-fat soybean meal	25.00	25.00	25.00	25.00	25.00	24.00	24.00	24.00	24.00	24.00
Blood meal	5.00	5.00	5.00	5.00	5.00	3.00	3.30	3.56	3.84	4.11
Wheat offal	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Fish meal	5.00	5.00	5.00	5.00	5.00	4.70	4.70	4.70	4.70	4.70
Bone meal	3.00	3.20	3.40	3.75	3.80	4.00	4.00	3.80	3.60	3.34
Oyster shell	2.50	2.30	2.10	1.75	1.70	3.00	2.70	2.64	2.56	2.55
Salt	0.50	0.50	0.50	0.50	0.50	1.00	1.00	1.00	1.00	1.00
Vitamin/mineral premix*	0.70	0.70	0.70	0.70	0.70	1.00	1.00	1.00	1.00	1.00
Methionine	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Determined content										
Dry matter (%)	89.51	89.21	89.45	89.59	89.34	88.49	89.21	90.45	89.59	89.34
Crude protein (%)	23.23	23.55	23.61	23.68	23.06	21.07	20.55	19.96	20.68	21.06
Crude fibre (%)	8.80	9.05	10.88	11.37	12.99	10.80	12.05	14.88	13.97	14.99
Ether extract (%)	5.79	5.07	6.93	7.06	8.62	4.79	5.02	4.73	5.06	4.68
Ash (%)	12.72	12.93	13.58	12.89	12.78	12.72	12.93	13.58	12.89	12.78
NFE (%)[2]	38.90	38.61	34.45	34.59	27.97	39.11	38.66	37.30	36.99	35.83
ME (kcal kg^{-3})	2767.78	2754.42	2670.82	2689.01	2610.85	2659.82	2643.42	2558.84	2592.21	2534.01

[1]DESM: *Dacryodes edulis* seed meal (% Dry matter: 89.53; %Crude protein: 6.98; % Ether extract: 8.98; % Crude fibre: 7.42; % Ash: 3.36; % NFE[2]: 73.26; ME[3]: 3368.04 kcal kg^{-1}). [2]NFE: Nitrogen-free extract; [3]ME: Metabolizable energy. *The Vit./Min. premix (Animal Care Services Consult Nig. Ltd., Lagos) provided The following vitamins and minerals kg^{-1} of diet: Vit. A: 8,000 I.U.; Vit. D_3: 18,000 I.U; Vit. E: 20 I.U.; Vit. K: 2.0 mg; Vit. B_1: 1.55 mg; Vit. B_2: 4.4 mg; Vit. B_6: 2.35 mg; Vit. B_{12}: 0.013 mg; Biotin: 0.042 mg; Niacin: 23.5 mg; Pantothenic acid: 6.5 mg; Folic acid: 0.65 mg; Mn: 75 mg; Zn: 45 mg; Fe: 20 mg; Cu: 5 mg; I: 1.0 mg; Se: 0.01 mg; Co: 0.02 mg; B.H.T.: 90 mg; Ethoxyquin: 33 mg; Choline: 150 mg

replicate were weighed at on arrival and at weekly intervals thereafter. Mean weekly live weight gain was obtained by adding over the weight of birds in the replicate, subtracting the previous week's value from it and dividing the result by the number of birds in the replicate. From the day of arrival, the broilers in each replicate were fed weighed quantities of feed daily and at the end of each day, the left-over feed was collected, air-dried and weighed; the weight was subtracted from that of the initial feed offered to obtain the feed intake. Feed: Gain ratio was determined by dividing the cumulative amount of feed consumed in each replicate by the weight gained during the same period by birds in this replicate. Percent mortality was obtained per replicate by expressing the number of deaths (by day 56) as a percentage of the initial number of birds (15) in each replicate.

Metabolic trial: At the end of 8 weeks of feeding the experimental broiler diets, three birds were selected at random from each replicate for a metabolism trial. The birds were single housed in battery cages and fed their respective experimental finisher diets. Feed and water were provided *ad libitum*. After an initial adjustment period of 3 days, dropping trays covered with aluminium foil were placed under the birds for total excreta collection for another three days. The amount of

feed consumed daily over the metabolic trial period was recorded. Care was taken to ensure that the faecal materials were free of feed. The faecal materials were oven-dried at 60-80°C, pooled on replicate basis and ground with a hammer mill. Representative samples of the faeces and the experimental diets were then analyzed for their respective proximate and mineral contents from which nutrients retained or digested were computed.

Data collection: The performance indices measured or computed during the starter and finisher phases included live weight gain, feed intake, feed: gain ratio, percent mortality of the birds, cost of feed consumed bird^{-1}, feed cost kg^{-1} weight gain, cost differential kg^{-1} weight gain and relative cost benefit kg^{-1} weight gain. Data on fat and nitrogen retention, crude fibre and dry matter digestibility were also collected.

The experimental designs and data analysis: The experiment was a Completely Randomised Design (CRD) with five dietary treatments in which DESM replaced maize at 0, 15, 30, 45 and 60%. The birds in each treatment were further divided into three replicates of 15 birds each. All data collected were analysed using the one-way analysis of variance procedure (Steel and Torrie, 1980). Means showing significant differences were separated using the Duncan's Multiple Range Test (Duncan, 1955).

RESULTS

Body weights, feed intake and mortality: Table 2 summarizes the performance of the broilers in terms of their body weights, feed consumption and mortality at the starter (0-28 days) and finisher (29-56 days) phases of production and for the entire production period (0-56 days). During the starter phase, the mean final body weights, overall weight gains and the average daily gains

Table 2: Performance of broilers fed the experimental starter and finisher diets (Mean±SE)

	Levels of DESM substitution (%)				
Parameters	0	15	30	45	60
Starter phase (0-28 days)					
Average initial body weight (g bird^{-1})	42.86±0.19^{c}	47.98±0.57^{ab}	47.13±0.85^{ab}	45.04±1.19^{bc}	50.00±1.44^{a}
Average final body weight (g bird^{-1})	554.17±24.50^{a}	474.70±5.07^{bc}	518.73±14.65^{ab}	455.72±17.69^{c}	430.00±15.28^{c}
Weight gain (g bird^{-1})	511.31±24.68^{a}	426.72±4.50^{bc}	471.60±15.15^{ab}	410.68±17.17^{c}	380.00±14.21^{c}
Average weight gain (g/bird/day)	18.26±0.88^{a}	15.24±0.16^{bc}	16.84±0.54^{ab}	14.67±0.61^{c}	13.57±0.51^{c}
Feed intake (g/bird/day)	38.37±0.16^{a}	40.27±40.27^{a}	41.42±1.29^{a}	38.06±1.34^{a}	37.33±0.39^{a}
Feed: Gain ratio	2.11±0.09^{b}	2.64±0.13^{a}	2.46±0.08^{a}	2.60±0.47^{a}	2.75±0.79^{a}
Finisher phase (28-56 days)					
Average final body weight (g bird^{-1})	1534.92±43.37^{a}	1540.18±14.64^{a}	1612.67±49.44^{a}	1242.62±9.62^{b}	1297.64±9.62^{b}
Weight gain (g bird^{-1})	981.08±43.24^{a}	1027.67±31.57^{a}	1093.95±51.08^{a}	727.23±31.16^{a}	867.64±7.34^{a}
Average weight gain (g/bird/day)	35.04±1.54^{a}	36.63±1.07^{a}	39.07±1.82^{a}	25.97±1.11^{a}	30.99±0.26^{a}
Feed intake (g/bird/day)	108.61±1.40^{b}	110.23±0.54^{b}	128.08±3.93^{a}	109.31±1.19^{b}	132.40±4.08^{a}
Feed: Gain ratio	3.11±0.14^{b}	3.01±0.10^{b}	3.29±0.17^{b}	4.23±0.19^{a}	4.27±0.11^{a}
Overall (0-56 days)					
Weight gain (g bird^{-1})	1491.73±43.16^{a}	1492.20±14.64^{a}	1565.55±50.14^{a}	1197.58±49.55^{b}	1247.64±8.26^{b}
Average weight gain (g/bird/day)	26.64±0.77^{a}	26.64±0.26^{a}	27.95±0.90^{a}	21.39±0.89^{b}	22.28±0.15^{b}
Feed intake (g/bird/day)	73.49±0.73^{b}	74.92±1.59^{b}	85.41±2.74^{a}	73.52±1.97^{b}	85.13±2.21^{a}
Feed: Gain ratio	2.76±0.08^{c}	2.81±0.08^{c}	3.05±0.15^{c}	3.44±0.05^{b}	3.82±0.09^{a}

SE: Standard error. Within each row, means with different superscripts are significantly different ($p<0.05$)

varied significantly ($p<0.05$) with dietary treatments, with the highest values occurring in the control treatment (0% DESM) (554.17±24.50, 511.31±24.68 g bird^{-1} and 18.26±0.88 g/bird/day, respectively) and the lowest in chicks fed diets in which 60% of the dietary maize was replaced with DESM (430.00±15.28, 380.00±14.21 g bird^{-1} and 13.57±0.51 g/bird/day, respectively). However, chicks on the control treatment were not significantly ($p>0.05$) different from those which received 30% dietary DESM replacement, but were significantly ($p<0.05$) superior, in all three parameters, to those on the 45 and 60% levels of maize replacement with DESM. By the end of the finisher phase, the final body weights of broilers with 0, 15 and 30% maize replacement levels were similar ($p>0.05$), but were significantly ($p<0.05$) higher than those of broilers on 45 and 60% levels of maize substitution with DESM. Mean weight gain of the broilers followed the same general pattern as the final body weights of the birds during the finisher phase while the average daily gains were unaffected ($p>0.05$) by variations in dietary DESM levels. Feed intake was highest during the starter phase (41.42±1.29 g/bird/day) in chicks that were fed diets in which 30% of the dietary maize was replaced with DESM and lowest (37.33±0.39 g/bird/day) in chicks on the 60% replacement treatment, although the differences were not significant ($p>0.05$). Data from the finisher phase, however, indicated a steady increase in feed intake as the level of DESM in the diet was increased, with broilers that received 45 and 60% dietary DESM for maize substitution consuming significantly ($p<0.05$) more feed than those in the other treatments. Feed: Gain ratio during the starter phase was similar ($p>0.05$) in chicks that were fed the test ingredient (DESM) but were significantly ($p<0.05$) higher than that recorded in the control chicks. Results obtained for the entire production period (0-56 days) indicated a general decline in average body weight gain of the broilers beyond 30% level of maize replacement with the test ingredient (DESM) in the diet and a general increase in average feed intake (g/bird/day) and in Feed: Gain ratio as more DESM was incorporated into the diets. The differences were significant ($p<0.05$).

Bird mortality occurred only during the starter phase (0-28 days), with broilers which received 30% level of maize replacement with DESM in their diets recording a significantly ($p<0.05$) higher mortality (11.11%) than those in each of the other treatments (2.22%).

Nutrient retention and digestibility: The result of the metabolism trials is presented in Table 3. All the parameters (nitrogen and fat retention and crude fibre and dry matter digestibility) generally decreased as the proportion of the test ingredient (DESM) in the broiler diets was increased. Incorporation of the test ingredient into the broiler diets significantly ($p<0.05$) reduced nitrogen retention in the broilers. Nitrogen retention in the control birds was significantly ($p<0.05$) higher than that in broilers fed the DESM-based diets. Among the broilers fed with DESM diets, those on the 15% maize replacement were similar to those on the 30% levels of replacement but significantly higher than those on diets with 45 and 60% levels of maize substitution with DESM

Table 3: Nutrient digestibility and retention of the broilers at 56 days of age

	Levels of DESM substitution (%)				
Parameters (%)	0	15	30	45	60
Dry matter digestibility	63.16±0.54^{a}	60.56±0.73^{ab}	58.30±4.00^{ab}	59.26±1.28^{ab}	55.54±2.83^{b}
Crude fibre digestibility	58.28±5.47^{a}	55.02±3.03^{a}	50.63±0.51^{ab}	44.65±2.53^{b}	40.63±0.81^{c}
Nitrogen retention	68.27±0.95^{a}	64.73±0.92^{b}	62.81±0.75^{bc}	61.09±1.00^{c}	59.47±1.66^{c}
Fat Retention	93.47±0.71^{a}	90.74±0.45^{a}	89.99±0.05^{a}	88.07±1.39^{ab}	81.80±2.28^{b}

Within the same row, means with different superscripts are significantly different ($p<0.05$). DESM: *Dacryodes edulis* seed meal

Table 4: Economic analysis of the effect of feeding varying levels of *Dacryodes edulis* Seed Meal (DESM) to broilers (Mean±SE)

	Levels of DESM substitution (%)					
Parameters	0	15	30	45	60	Significance
Cost of total feed consumed/bird (NGN)						
0-28 days	68.48±0.27^{a}	67.92±2.68^{a}	65.15±2.02^{a}	55.59±1.95^{b}	50.56±0.52^{b}	**
29-56 days	186.20±1.38^{ab}	173.45±6.77^{bc}	193.24±5.93^{a}	151.85±1.64^{d}	167.74±5.16^{c}	**
0-56 days	254.68±1.23^{a}	241.37±8.36^{a}	258.39±6.76^{a}	207.44±3.58^{b}	218.30±5.29^{b}	**
Cost kg^{-1} body weight gain (NGN)						
0-28 days	124.04±5.05^{b}	143.24±12.50^{a}	125.68±3.50^{b}	123.58±1.46^{b}	117.81±3.31^{b}	*
29-56 days	121.52±3.74^{a}	112.63±5.33^{a}	119.96±4.08^{a}	122.49±3.65^{a}	129.28±4.06^{a}	ns
0-56 days	166.21±5.11^{a}	156.85±6.87^{a}	160.49±6.04^{a}	167.24±3.91^{a}	168.24±4.11^{a}	ns
Cost differential kg^{-1} weight gain (NGN)						
0-28 days	-	-19.22±7.22^{c}	-1.66±3.50^{b}	0.44±1.46^{b}	6.21±3.31^{a}	*
29-56 days	-	8.89±5.33^{a}	1.56±4.08^{b}	-0.97±3.65^{b}	-7.76±4.06^{c}	*
0-56 days	-	9.36±6.87^{a}	5.72±6.04^{a}	-1.03±3.91^{b}	-2.03±4.11^{b}	*
Relative cost benefit kg^{-1} weight gain (%)						
0-28 days	100.00±0.00	87.00±4.17^{b}	98.83±2.74^{a}	100.38±1.18^{a}	102.44±1.91^{a}	*
29-56 days	100.00±0.00	108.40±5.38^{a}	101.53±3.37^{a}	99.38±2.90^{a}	94.19±3.05^{a}	ns
0-56 days	100.00±0.00	106.39±4.84^{a}	103.86±3.96^{a}	99.49±2.30^{a}	98.91±2.47^{a}	ns

ns: Not significant (p>0.05); SE: Standard error; NGN: Nigerian naira. *Significant (p<0.05); **Highly significant (p<0.01). Means within a row with the same superscript do not differ significantly (p>0.05)

in the proportion of nitrogen retained. There were no significant (p>0.05) differences in mean fat retention between broilers on the control diet and those on the 15, 30 and 45% maize replacement treatments and among birds on the control diet and those fed 15 and 30% replacement diets for crude fibre digestibility. However, more fat was retained and more crude fibre digested by the control broilers and those which received the 15% DESM for maize compared to those fed diets with 45 and 60% levels of maize replacement. Mean dry matter digestibility was similar (p>0.05) in all treatments, but was significantly higher in the control treatment than in the 60% DESM substitution treatment.

Economic analysis: Table 4 shows the result of the economic analysis of the production of the broilers fed varying levels of the test ingredient, *Dacryodes edulis* seed meal. Increasing replacement of dietary maize with DESM above 30% highly significantly (p<0.01) reduced the cost, in Nigerian naira (NGN), of feed consumed bird^{-1} in both phases of production. The cost kg^{-1} of b.wt. gain generally declined significantly during the starter phase (p<0.05). However, differences in cost kg^{-1} of b.wt. gain were not significant (p>0.05) during the finisher phase and for the entire production period. Cost differential kg^{-1} gained by the broilers increased significantly (p<0.05) as the level of DESM in the diet was increased during the starter phase. They were positive only at the 45 and 60% levels of dietary DESM. During the finisher phase and for the entire production period, cost differential decreased significantly (p<0.05) with dietary treatments, with positive values recorded at the 15 and 30% levels of DESM incorporation in the broiler diets. Relative cost benefit kg^{-1} b.wt. gain (%) also increased significantly (p<0.05) as the level of DESM in the diet was increased during the starter phase with the 45 and 60% DESM dietary treatments recording more than 100%. Increased incorporation of the test ingredient into the feed, however, had no significant (p>0.05) effect on the mean percent cost benefit kg^{-1} b.wt. gain during the finisher phase and for the entire period of production. However, incorporation of the test ingredient into the broiler diets

beyond 30% depressed the cost benefit below 100% during the finisher phase and for the entire production period.

DISCUSSION

Body weights, feed intake and mortality: During the starter phase, the mean final body weights, weight gains and average daily gains of chicks that received 30% DESM for maize were not significantly ($p>0.05$) different from those of the control and 15% groups. However, the control birds were significantly ($p<0.05$) superior to those in which DESM replaced 45 and 60% dietary maize in all three parameters. This is an indication that broiler chicks can tolerate up to 30% maize replacement with *Dacryodes edulis* Seed Meal (DESM) in their diets. Although, the mean final body weights of the broilers at the end of the finisher phase were significantly ($p<0.05$) higher for birds which were fed diets substituted at levels of 0-30% than for birds that received diets with 45 or 60% substituted DESM, variations in mean body weight gain and in average daily gains were unaffected ($p>0.05$) by variations in dietary DESM levels, thus indicating that as the broilers grew older, they were better able to tolerate more of the test ingredient in their diets (Attia *et al*., 2003). Data on body weight gains for the overall production period (0-56 day), however, show that gains were significantly ($p<0.05$) depressed in the broilers when the level of maize substitution in their diets exceeded 30%. This suggests that incorporation of DESM into broiler rations in place of maize should generally not exceed 30%.

Although, feed intake was not significantly influenced by variations in dietary DESM levels during the starter phase, the broilers tended to consume significantly ($p<0.05$) more feed and feed: Gain ratio increased as the level of dietary DESM was increased during the finisher phase. Since, DESM is a more fibrous ingredient than maize which it replaced in this study, the broilers, as they grew bigger, had to consume more of the feed in an attempt to meet their increasing energy needs. This is in agreement with the findings of Drovak and Bray (1978), Nwokolo *et al.* (1985), Babatunde and Oluyemi (2000) and Adeniji (2005), who observed increased feed intake and poor body weight performances as fibrous ingredients were used at increasing levels in broiler diets.

Since, observed mortality was 2.22% at each of the levels of maize substitution below and above the 30% level, the significantly higher mortality at the 30% level (11.11%) during the starter phase is unlikely to be as a result of increase in the concentration of DESM in the diets. On the whole, mortality obtained in this study was low and is an indication that the use of *Dacryodes edulis* seed meal as a feed ingredient to replace maize in broiler rations is not detrimental to the survival of broilers.

Nutrient retention and digestibility: The general decrease in nutrient digestibility and nitrogen retention when the level of the test ingredient in the broiler diets was increased is due to the fibrous nature of the test ingredient which may have hindered digestion. Similar findings were reported by Farinu *et al.* (1999), Nworgu *et al.* (2000), Aderemi *et al.* (2005) and Ajaja (2005). The similarity in the proportion of nitrogen and fat retained and in the amount of crude fibre digested between broilers fed the control diet and those of the 30% substitution treatment suggests that up to 30% of dietary maize in conventional broiler diets may be replaced with *Dacryodes edulis* Seed Meal (DESM) without deleterious effects on digestibility of these nutrients.

Economic analysis: Generally, there were significant ($p<0.01$) reductions in the cost of total feed consumed bird^{-1} during the starter, finisher and overall production periods as the test ingredient

was incorporated above 30% level, in their diets. This is important because a reduction of one NGN in feed costs becomes very substantial in very large broiler production enterprises. The cost of producing a kilogram of body weight gain between broilers on the control dietary treatment and those on the 45 and 60% DESM dietary treatments at all the production phases (0-28, 29-56 and 0-56 days) suggests that DESM may be most profitably utilized in broiler diets at 60% level of substitution. However, records of cost differential kg^{-1} weight gain were positive only at the 45 and 60% levels of maize substitution with the test ingredient for the starter chicks and at the 15 and 30% levels for the finisher phase and for the overall production period. This implies that DESM can profitably replace up to 60% of the dietary maize during the starter phase, but not more than 30% during the finisher phase.

CONCLUSION

Replacement of up to 60% of the dietary maize with DESM was well tolerated by the broilers, although growth was significantly depressed at the upper levels of dietary DESM. Overall mortality was within tolerable limits. Dry matter and crude fibre digestibility and nitrogen and fat retention generally decreased significantly with increasing levels of dietary DESM. Moreover, from an economic point of view, it was more profitable to utilize DESM at the upper levels (45 and 60%) in starter diets but not more than 30% in finisher diets.

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