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# Use of *Dacryodes edulis* Seed Meal (DESM) as a Replacement for Maize in Broiler Diets: Effects on Carcass Attributes, Organ Weights and Organoleptic Quality

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**Abstract:** In an investigation to determine the effects of utilizing seeds of the African Pear (*Dacryodes edulis* G. Don, H.J. Lam) as a replacement for maize in the diets of broiler chickens on the carcass and organ weights and on the organoleptic properties of the birds, two hundred and twenty-five (225) day-old Anak broilers were randomly assigned to five dietary treatments with 45 birds per treatment in which DESM replaced maize at 0% (control), 15%, 30%, 45% and 60% levels 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 fifteen (15) birds each and provided the feed and water *ad libitum*. The carcass and organ weights and organoleptic quality indices did not differ significantly ($p>0.05$) with variations in the level of DESM in the diets. Breast weight generally tended to decrease as the proportion of DESM in the diet was increased. Broilers which received 60% DESM for maize diets had the highest head, drumstick, thigh and neck weights (expressed as percentages of EW) while the control treatment produced the lowest drumstick, thigh and wing weights (as percentages of EW). Besides the heart, the proportions of the liver, pancreas and spleen were generally numerically higher at 45% and 60% levels of maize substitution with DESM than the control values. Meat tenderness, juiciness, flavour and overall acceptability were unaffected ($p>0.05$) by the level of inclusion of *Dacryodes edulis* Seed Meal (DESM) in the broiler diets. The coefficients of linear correlation between the meat quality variables were non-significant except for that between juiciness and flavour. It was concluded that DESM, when used to replace up to 60% of the maize in broiler diets does not adversely alter the ability of broilers to synthesize muscle and organ tissue.

**Key words:** *Dacryodes edulis*, carcass, organoleptic, broilers, tropics

## INTRODUCTION

For commercial broiler chickens to produce at optimal levels of efficiency and attain the limits of their genetic potentials, they must be fed diets that can provide all of their nutrient requirements. Free-ranging poultry tend to select different items of diet according to their requirements. Where broilers are not kept on free range, as in intensive poultry production, care must be taken to ensure that all of the birds' nutrient requirements are provided in the feed supplied. Commercial broiler feeds are usually carefully formulated to meet the nutritional needs of the birds. However, while use of the best conventional feed ingredients are almost guaranteed to produce high performances, such finished feeds come at costs that are often too high to justify profitable production. For example, maize which is the conventional feed ingredient used to supply the bulk of the energy component of poultry feeds in Nigeria (Otokunefor and Olomu, 2000) accounts for about 70% of total feed costs and as much as 50% of farm gate prices of poultry products (Sibbald, 1982; Oruwario *et al*., 1999). Feed cost is therefore a key factor in determining profits from commercial broiler enterprises and continues to be a major challenge to stakeholders in the poultry industry, especially in developing countries. Broiler producers and feed manufacturers are constantly making attempts at finding a balance between optimizing broiler performance and minimizing feed costs. Research into and use of unconventional feed ingredients in poultry nutrition are aimed at finding cheaper and readily available alternatives to expensive feed ingredients.

Recent studies have shown that seeds of the African pear (*Dacryodes edulis* G. Don, H.J. Lam) contain high levels of energy (as lipids and soluble carbohydrates) (Bratte *et al*., 2010) and can be used to partially replace up to 30% of the dietary maize in broiler diets without deleterious effects on semen quality of broiler breeder cocks (Bratte *et al*., 2011) and body weight, nutrient digestibility and retention of broilers (Bratte, 2011). It therefore holds some potential in reducing feed costs and increasing profits of broiler producers in resource-poor countries of West Africa where *Dacryodes edulis* is widely grown.

Poultry meat is gaining wider acceptance in Nigeria partly because of its perceived lower cholesterol content compared to red meat from ruminants and because of the absence of religious or cultural barriers to its consumption. Consumers are also becoming increasingly conscious of the quality of meat they

purchase and consume. It is well known (Onibi *et al*., 2009) that the quality of meat is a function of the nutrients consumed by the animals while being reared. This study was therefore conducted to ascertain the effects of partial replacement of maize with *Dacryodes edulis* Seed Meal (DESM) in broiler diets on the carcass attributes, organ weights and organoleptic quality of broilers.

## MATERIALS AND METHODS

**Experimental site:** This study was conducted at the Poultry Unit of the Teaching and Research Farm of the Asaba Campus of the Delta State University, Asaba, Nigeria. Asaba is situated approximately on longitude 60 45' E and latitude 60 12' N and has a Derived Savannah vegetation type. Annual rainfall ranges from 1800 mm to 3000 mm while the maximum day temperatures range from 27.50-30.90°C. The area experiences a rainy season (April to September) and a dry season (October to March).

**The experimental birds:** Two hundred and twenty-five (225) day-old Anak broilers were randomly assigned to five dietary treatments with 45 birds per treatment and fed diets in which DESM replaced maize at 0% (control), 15%, 30%, 45% and 60% levels 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 fifteen (15) birds each and provided the feed and water *ad libitum*. The diets in each phase were formulated to be isocaloric and isonitrogenous with the starter diets containing approximately 2900 kcal/kg ME and 23% crude protein and the finisher diets containing approximately 3000 kcal/kg and 20% crude protein as earlier reported in Bratte *et al*. (2010).

**Determination of carcass attributes and organ weights:** At the end of 56 days of feeding, two birds were chosen at random from each replicate, starved overnight to empty their gut contents, weighed and sacrificed by decapitation. They were left hanging for about 15 min to bleed completely, scalded in hot water, plucked by hand, weighed and eviscerated. Parameters measured included the plucked carcass weight, eviscerated weight, dressed weight and the weights of the following cut parts expressed as percentages of the eviscerated weight: drumsticks, thighs, shanks, wings, breast, back, neck and head. The heart, liver, spleen, pancreas and gizzard were also weighed and their weights expressed as percentages of the dressed weight. The lengths (in cm) of the proventriculus, small intestine, colon and caeca were also measured and expressed in cm/100 g dressed weight.

**Organoleptic quality determination:** For each treatment, the thighs of the slaughtered birds were deboned and the muscles carefully cut into 15 bits of approximately 2g each. Care was taken to remove all tendons. The pieces were dipped in concentrated brine for approximately two seconds, packed singly into transparent polythene bags, tied tightly and put into boiling water to cook for approximately 20 min. Thereafter, they were presented in dishes under bright light to a trained 10-person sensory panel. A structure questionnaire, designed to solicit responses about tenderness, juiciness, flavour and overall acceptability of the meat using a nine-point Hedonic scale was thoroughly explained to the panel prior to the tasting session. Each panelist evaluated 15 meat samples for tenderness (1 = extremely tough; 9 = extremely tender), juiciness (1 = extremely dry; 9 = extremely juicy), flavour (1 = extremely unflavoured; 9 = extremely flavoured) and overall acceptability (1 = extremely unacceptable; 9 = extremely acceptable). Warm water was provided with which members of the panel rinsed their mouths between samples tasted.

**Experimental design and data analysis:** The experiment was a one-way classification in a Completely Randomized Design (CRD) with the following model:

$$X_{ij} = \mu + \alpha_i + e_{ij}$$

Where:

$X_{ij}$ = The observed value of each of the response variables (carcass and organ weights or organoleptic quality attributes)
$\mu$ = The overall population mean
$\alpha_i$ = Observed effect of the ith dietary treatment
$e_{ij}$ = Random or residual error due to the experimentation

A correlation matrix was also computed for the organoleptic quality attributes.

Data collected were analyzed 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

**Carcass and organ weights of the broilers at 56 days of age:** The results of the carcass evaluation and organ weights are presented in Table 1 and 2. The mean weights of carcass and proportions of the cut-up parts did not differ significantly ($p>0.05$) with variations in the level of DESM inclusion in the diets. Nevertheless, broilers which consumed diets in which 30% of its maize was replaced with DESM had the highest mean live weight, plucked weight and dressed weight (2.27±0.42, 2.17±0.42 and 1.69±0.36 kg respectively) while the lowest values of 1.90±0.23, 1.78±0.21 and 1.37±0.18 kg respectively were recorded in broilers with 45% of their dietary maize replaced with DESM.

Table 1: Carcass quality characteristics of broilers fed the experimental diets (Mean±SE)*

| | Levels of maize replacement with DESM (%) | | | | |
|---|---|---|---|---|---|
| Characteristics | 0 | 15 | 30 | 45 | 60 |
| Live Weight (LW) (kg) | 2.20±0.31 | 2.12±0.20 | 2.27±0.42 | 1.90±0.23 | 2.15±0.20 |
| Plucked weight (kg) | 2.01±0.29 | 1.98±0.21 | 2.17±0.42 | 1.78±0.21 | 2.08±0.20 |
| Dressed weight (kg) | 1.65±0.20 | 1.50±0.13 | 1.69±0.36 | 1.37±0.18 | 1.60±0.15 |
| Dressed weight (% LW) | 77.18±5.65 | 71.12±0.93 | 73.93±1.86 | 71.79±1.62 | 74.40±0.32 |
| Eviscerated Weight (EW) (kg) | 1.80±0.25 | 1.67±0.17 | 1.86±0.39 | 1.52±0.19 | 1.72±0.17 |
| Eviscerated weight (% LW) | 81.92±2.49 | 78.69±1.87 | 81.45±1.76 | 80.08±0.43 | 79.81±2.09 |
| Head weight (g) | 59.13±0.11 | 51.84±0.88 | 59.43±9.84 | 54.60±5.91 | 61.00±10.39 |
| Shank weight (% EW) | 5.68±0.82 | 4.88±0.25 | 5.35±0.47 | 5.60±0.16 | 5.59±0.27 |
| Breast weight (% EW) | 24.77±1.19 | 23.50±0.56 | 24.78±2.07 | 24.04±0.06 | 23.56±1.51 |
| Back weight (% EW) | 19.18±0.64 | 19.51±1.09 | 18.59±0.31 | 19.53±0.92 | 19.39±0.82 |
| Drumstick (% EW) | 13.83±1.00 | 14.75±0.89 | 14.40±0.43 | 14.53±0.57 | 15.24±0.53 |
| Thigh (% EW) | 13.86±1.00 | 14.36±0.31 | 14.50±0.39 | 14.21±0.35 | 15.67±0.53 |
| Wing (% EW) | 9.85±0.07 | 10.43±0.33 | 10.59±0.23 | 10.40±0.16 | 10.08±0.08 |
| Neck (% EW) | 6.65±0.19 | 6.93±0.32 | 6.40±0.85 | 6.54±0.27 | 7.17±0.39 |

SE = Standard Error. *All means were not significantly different (p>0.05). DESM = *Dacryodes edulis* Seed Meal

Table 2: Organ weights of broilers fed the experimental diets (Mean±SE)*

| | Levels of maize replacement with DESM (%) | | | | |
|---|---|---|---|---|---|
| Characteristics | 0 | 15 | 30 | 45 | 60 |
| Heart weight (% DW) | 0.67±0.07 | 0.63±0.04 | 0.58±0.06 | 0.64±0.02 | 0.58±0.04 |
| Liver weight (% DW) | 2.63±0.09 | 2.93±0.03 | 2.46±0.06 | 2.90±0.12 | 3.09±0.37 |
| Pancreas weight (% DW) | 0.29±0.01 | 0.31±0.01 | 0.27±0.03 | 0.39±0.04 | 0.37±0.06 |
| Spleen weight (% DW) | 0.27±0.06 | 0.22±0.02 | 0.27±0.02 | 0.26±0.03 | 0.27±0.04 |
| Gizzard weight (without linings) (% DW) | 2.61±0.19 | 2.88±0.23 | 2.87±0.48 | 3.51±0.33 | 2.95±0.12 |
| Colon length (cm/100 g DW) | 0.83±0.08 | 0.76±0.02 | 0.68±0.09 | 0.85±0.18 | 0.93±0.09 |
| Small intestine (cm/100 g DW) | 10.86±0.65 | 12.35±1.04 | 11.57±1.47 | 13.87±1.03 | 13.49±1.29 |
| Proventriculus (cm/100 g DW) | 0.33±0.04 | 0.38±0.03 | 0.34±0.07 | 0.38±0.05 | 0.36±0.25 |
| Caecum (cm/100 g DW) | 2.50±0.16 | 2.85±0.26 | 3.03±0.54 | 3.29±0.44 | 3.36±0.25 |

SEM = Standard Error; DESM = *Dacryodes edulis* Seed Meal; DW = Dressed Carcass Weight; *All means were not significantly different (p>0.05)

Eviscerated Weight (EW), expressed as a percentage of Live Weight (LW), was highest with broilers on the control diet (77.18±5.65%) and lowest in broilers on the 15% DESM for maize diet (71.12±0.93%). Birds on the 30% DESM replacement diet had the highest breast weight, while those fed the control diet had the highest shank weight (expressed as percentages of EW). Breast weight generally tended to decrease as the proportion of DESM in the diet was increased. Broilers which received 60% DESM for maize diets had the highest head, drumstick, thigh and neck weights (expressed as percentages of EW) while the control treatment produced the lowest drumstick, thigh and wing weights (as percentages of EW).

Variations in the proportions of organ weights were unaffected (p>0.05) by variations in dietary DESM levels. Broilers in the control treatment had the highest mean heart weight (as a proportion of the DW) (0.67±0.07%), while birds on the 60% DESM diet had the lowest (0.58±0.04%). Except for broilers on the 30% DESM replacement diet, birds which consumed the DESM-based diets had higher liver weights than those on the control diet, with the highest proportion occurring in broilers on the 60% DESM for maize diet. Mean pancreas weight (as a proportion of DW) ranged from 0.39±0.04% in broilers on the 45% dietary DESM for maize diet to 0.27±0.02% for broilers which received diets with 30% of maize replaced with DESM. The 45% and 60% DESM replacement diets produced the highest gizzard weights (without linings) (3.51±0.33 and 2.95±0.12% of DW respectively) while broilers on the control treatment recorded the lowest value (2.61±0.19%). The lengths of the proventriculus, small intestine, colon and caecum (cm/100 g DW) were generally higher in broilers fed 45% and 60% dietary DESM for maize diets than in those fed the control diet.

**Organoleptic quality of the broilers at 56 days of age:** The results of the organoleptic quality test of the broilers at 56 days of age and the linear correlation matrix for the various meat quality parameters are presented in Table 3 and 4 respectively. All the parameters measured (meat tenderness, juiciness, flavour and overall acceptability) were unaffected (p>0.05) by the level of inclusion of *Dacryodes edulis* Seed Meal (DESM) in the broiler diets. Generally, the meat was adjudged to be moderately to slightly tender, juicy and flavoured and to be moderately to highly acceptable. The coefficients of linear correlation between the meat quality variables were non-significant except for that between juiciness and flavour.

Table 3: *Organoleptic quality of the broilers fed varying levels of *Dacryodes edulis* Seed Meal (DESM) (Mean±SE)

| Meat quality Characteristics | Levels of DESM inclusion (%) 0 | 15 | 30 | 45 | 60 | Overall |
|---|---|---|---|---|---|---|
| Tenderness | 7.07±0.25 | 7.07±0.27 | 6.64±0.39 | 6.57±0.47 | 7.07±0.36 | 6.88±0.11 |
| Juiciness | 7.14±0.18 | 6.93±0.27 | 6.93±0.22 | 6.79±0.35 | 6.50±0.31 | 6.86±0.11 |
| Flavour | 7.21±0.24 | 7.07±0.22 | 7.00±0.36 | 7.14±0.20 | 6.57±0.25 | 7.00±0.11 |
| Overall acceptability | 7.86±0.18 | 7.14±0.25 | 7.29±0.24 | 7.45±0.29 | 7.29±0.30 | 7.41±0.12 |

SE = Standard Error; *Means were based on a nine-point Hedonic scale as follows: 9 = Extremely tender, juicy, flavoured, acceptable; 8 = Very tender, juicy, flavoured, acceptable; 7 = Moderately tender, juicy, flavoured, acceptable; 6 = Slightly tender, juicy, flavoured, acceptable; 5 = Neither tender nor tough, juicy nor dry, flavoured nor unflavoured, acceptable nor unacceptable; 4 = Slightly tough, dry, unflavoured, unacceptable; 3 = Moderately tough, dry, unflavoured, unacceptable; 2 = Very tough, dry, unflavoured, unacceptable; 1 = Extremely tough, dry, unflavoured, unacceptable

Table 4: Linear correlation matrix between the meat quality traits

| Meat quality traits | Tenderness | Juiciness | Flavour | Acceptability |
|---|---|---|---|---|
| Tenderness | - | $0.03^{ns}$ | $-0.28^{ns}$ | $0.10^{ns}$ |
| Juiciness | - | - | 0.88* | $0.53^{ns}$ |
| Flavour | - | - | - | $0.48^{ns}$ |
| Acceptability | - | - | - | - |

*p<0.05; ns = not significant (p>0.05)

## DISCUSSION

**Carcass and organ weights of the broilers at 56 days of age:** The non-significance of the effect of feeding varying levels of *Dacryodes edulis* Seed Meal (DESM) to broilers on their carcass weights is an indication that the use of DESM as a feed ingredient at the specified levels in the broiler diets did not interfere with normal tissue synthesis in the birds. The carcass measurements obtained in this study are consistent with values reported by Asika *et al.* (2006) and Nwokoro and Obasuyi (2006) for Anak broilers in a humid tropical environment. The live weight and the gross carcass weights (plucked, eviscerated and dressed weights) of the broilers, though not significant, appear to have been best at the 30% level of replacement of maize with DESM. The proportions of breast, drumstick and thigh, which are the best indices of muscle development, tended to be higher at 30% (for breast weight) or higher levels of DESM for maize incorporation (for drumstick and thigh weights).

The higher, but non-significant, proportions of head and shank measurements associated with lower levels of dietary DESM (0% and 15% of dietary maize) agree with the findings of Okon and Ogunmodede (1995) and Okuedo *et al.* (2005) who obtained smaller percentage heads and shanks in broilers at higher levels of dietary inclusion of palm kernel cake. The latter authors argued that dietary sources high in non-starch polysaccharides, probably through the carboxyl groups of the uranic acids, could bind bivalent cations such as Ca which, in turn, result in smaller heads and shanks.

Apart from the heart, the proportions of the other major organs (liver, pancreas and spleen) were generally higher at 45% and 60% levels of maize substitution DESM thus indicating that DESM induced a greater level of physiological activity in the broilers at higher levels of inclusion.

The more fibrous nature of DESM (Bratte *et al.*, 2010) may have accounted for the higher proportions of proventriculus, gizzard, small intestines, colon and caeca at the higher levels of DESM inclusion. It has been shown (Krogdahl, 1986; Hetland *et al.*, 2004) that in poultry, more fibrous feed ingredients stimulate heavier gizzards, larger pancreas and longer guts than less fibrous feeds in order to better handle the greater bulk mass in such feeds.

The coefficients of linear correlation between the meat quality variables were non-significant except for that between juiciness and flavour. Juiciness and flavour were, in this study, found to be more important than tenderness in determining overall acceptability of the meat. Gueye *et al.* (1997) also found flavour as the most important sensory determinant of total score of breast and thigh meat of broilers.

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