ISSN 1819-1878

Asian Journal of Animal Sciences

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Asian Journal of Animal Sciences 5 (1): 71-79, 2011
ISSN 1819-1878 / DOI: 10.3923/ajas.2011.71.79

The Effects of Partial Replacement of Dietary Maize with Seeds of the African Pear (*Dacryode edulis* G. Don, H.J. Lam) on Semen Characteristics of Broiler Breeder Cocks

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ABSTRACT

In an investigation conducted to determine the effect of utilizing seeds of the African Pear (*Dacryodes edulis* G. Don, H.J. Lam) as a feed ingredient in the diets of broiler breeders on semen characteristics, 25 adult Anak Titan breeder cocks aged 20 weeks were randomly allotted to five dietary treatments of 5 cocks per treatment and fed diets in which *Dacryodes edulis* seed meal (DESM) replaced maize at 0% (control), 15, 30, 45 and 60% for 8 weeks. After 2 weeks of feeding the experimental diets, semen was collected twice weekly from the cocks by the lumbar massage technique. Semen colour or consistency scores were significantly lower for cocks which received the control and 15% DESM diets than for cocks on the 45 and 60% DESM diets. Mean semen volume was significantly ($p<0.01$) higher in cocks fed with 15, 30 and 45% DESM (0.33, 0.37 and 0.35 mL, respectively) than in those which received the control diet (0.21 mL) and in those fed 60% DESM (0.19 mL). Sperm concentration ($\times 10^6$ mL^{-1}) generally increased significantly ($p<0.01$) as the level of DESM in the diet was increased. Negative but non-significant ($p>0.05$) correlations existed between body weight and sperm motility, semen pH, ejaculate volume, sperm concentration and percent live sperm while body weight bore a positive (but non-significant) correlation with percent abnormal sperm and a highly significant ($p<0.01$) positive correlation with semen consistency (0.99). It was concluded that DESM had no adverse effect on semen quality of broiler breeders even if it replaced as much 45-60% of dietary maize in broiler breeder diets.

Key words: African pear, cocks, semen, broiler breeder

INTRODUCTION

The relationship between nutrition and reproductive performance in farm animals is well known. Research has shown that deficiencies of various trace minerals, inadequate vitamin intakes, energy-protein imbalances and excessive protein intakes contribute to infertility and poor reproductive performance of animals including chickens. For developing nations of the world to bridge the usual shortfalls in animal protein production and consumption among their human populations, adequate feed resources must be developed to meet the nutritional needs of its livestock.

Many researchers have identified increasing costs of feeds and other inputs as the greatest hindrance to the development of the poultry industry in Sub-Saharan Africa. Feed, an important

variable cost item in poultry production, is known to constitute the largest single item of cost in the production process (Osei and Twumasi, 1989) and could account for as much as 70-85% of total production costs in Nigeria (Akinwumi *et al*., 1979; Alabi *et al*., 1999). It is also known that maize, which is conventionally used to supply the bulk of the energy component of commercial poultry feeds in Nigeria (Otokunefor and Olomu, 2000), accounts for about 70% of total feed costs and 50% of farm gate prices of poultry products (Sibbald, 1982; Oruwari *et al*., 1999). The need for cheaper non-conventional alternatives to partially or wholly replace maize as a way of reducing the price of finished commercial poultry feeds in Nigeria is now widely recognized and this has inspired research on the possibility of utilizing sweet potato (Fetuga and Oluyemi, 1976), water hyacinth (Dairo, 1977), mango kernel meal (Faniyi, 1995), whole melon seed meal (Oruwari *et al*., 1999), cassava root meal (Eruvbetine, 2000), maize processing waste (Ukah, 2004) kolanut testa meal (Oke *et al*., 2004) raw breadfruit meal (Oladunjoye *et al*., 2005) and full fat palm kernel meal (Ugwuene *et al*., 2005) among many others as possible replacements for maize in poultry diets in Nigeria.

The African pear (*Dacryodes edulis* G. Don, H.J. Lam) is an oleiferous fruit tree believed to be native to South-Eastern Nigeria and perhaps, Cameroun (Vivien and Faure, 1996; Leaky *et al*., 2002) and can be found throughout West-Africa and in parts of central Africa. It is best known for its edible oily fruit pulp (ICUC, 2001) which is a highly cherished food item in South-Eastern Nigeria and Cameroun. The seeds, which are usually discarded after the pulp has been consumed, are available in large quantities during the fruiting season (May to October) in Nigeria. Investigations on chemical composition of the seeds of the African pear (Obasi and Okolie, 1993; ICUC, 2001; Ajayi and Oderinde, 2002; Bratte, 2007) show that it is high in energy in the form of soluble carbohydrate and lipids. This suggests that it may just be useful as a possible substitute for maize in non-ruminant feeding. Reports on the use of seeds of the African pear in broiler diets and of its effects on performance and reproduction of broiler breeders are virtually absent. This study was therefore conducted to ascertain the effects of partial replacement of maize with *Dacryodes edulis* seed meal (DESM) in broiler breeder diets on semen characteristics of breeder cocks.

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, located on longitude 60° 45' E and latitude 60° 12' N. It is situated in the Derived Savannah vegetation zone. Annual rainfall ranges from 1800 to 3000 mm while 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 experimental diets: Seeds of the African pear, *Dacryodes edulis* (G. Don, H.J. Lam) were collected from Asaba (Nigeria) and its environs, washed in water to remove all sand particles and de-hulled by removing the tough leathery coat with a knife to expose the cotyledons. The cotyledons were carefully separated by hand and spread out to dry under the sun for several days until a safe moisture level of 10-13% was attained. The dry cotyledons were then winnowed to remove all seed chaff and ground with a hammer mill to obtain *Dacryodes edulis* seed meal (DESM). Five diets, in which DESM replaced maize at 0, 15, 30, 45 and 60%, respectively, were formulated for adult male broiler breeders. All five diets (composition in Table 1) were made to contain approximately 17% crude protein and 2650 kcal kg^{-1} ME.

Table 1: Composition of the experimental diets for the adult breeder cocks

	Dietary treatments				
	Levels of DESM inclusion (%)				
Ingredients	0 (Control)	15	30	45	60
Maize	48.00	40.80	33.60	26.40	19.20
DESM	0.00	7.20	14.40	21.60	28.80
Full-fat soybean meal	14.00	14.00	14.00	14.00	14.00
Wheat offal	20.00	20.00	20.00	20.00	20.00
Fish meal	3.00	3.00	3.00	3.00	3.00
Bone meal	4.50	4.00	4.00	3.80	3.50
Oyster shell	8.00	7.90	7.46	7.14	6.87
Salt	1.00	1.00	1.00	1.00	1.00
Vitamin and mineral premix*	1.00	1.00	1.00	1.00	1.00
Methionine	0.30	0.30	0.30	0.30	0.30
Lysine	0.20	0.20	0.20	0.20	0.20
Analyzed					
Dry matter (%)	89.51	89.21	89.45	89.59	89.34
Crude protein (%)	23.23	23.55	23.61	23.68	23.06
Crude fibre (%)	8.80	9.05	10.88	11.37	12.99
Ether extract (%)	4.79	5.02	4.93	5.06	4.68
Ash (%)	12.72	12.93	13.58	12.89	12.78
Nitrogen-free extract (%)	36.96	38.66	36.45	36.59	35.83
M×E (kcal kg^{-1})	2656.05	2654.42	2670.82	2689.01	2608.01

*The Vit./Min. premix (Animal Care Services Consult Nig. Ltd., Lagos) provided. The following vitamins and minerals per kg 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

The experimental animals: Twenty-five 20 week old Anak Titan breeder cocks were used for the study. The cocks were randomly allotted to five treatments of 5 cocks each and housed singly in the battery cages. Each cock represented an observation. The cocks were given an anti-stress formulation, Agrivit®, (by Koffolk Ltd., Tel Aviv, Israel) at 40 g L^{-1} of drinking water on arrival and fed the experimental diets thereafter for 8 weeks. Feed and water were provided *ad libitum*. Their droppings were cleared daily.

Semen collection and evaluation: Semen was collected twice weekly (Tuesdays and Thursdays) from the cocks for 6 weeks by the lumbar massage technique of Burrows and Quinn (1937) after a pre-trial training period of 2 weeks. Each breeder was a replicate. 3, 4 or all 5 breeders (i.e., 60-100%) responded each time they were milked. Data from 2 collections were pooled. Each semen sample was evaluated for its colour (consistency), volume, pH, sperm motility, sperm concentration and percent live sperm. Semen volume was determined by drawing the semen with a 1 mL tuberculin syringe and reading directly to the nearest 0.01 mL. Consistency was visually evaluated using the following three colour categories: 1 for creamy and grainy; 2 for milky and 3 for watery (Zemjanis, 1970). Semen pH was determined with a p-Hydrion paper and compared with colours on a colour chart. Sperm motility was subjectively evaluated by placing a drop of fresh semen on a microscope slide, pre-warmed to 37°C, covering it with a cover slip and examining it at 100x

magnification under a light microscope. The vigour of the wave motion observed was scored on a 0-100 scale (0 for no motility and 100 for very vigorous, churning motion). Sperm concentration was determined by counting diluted sperm with a Neubauer haemocytometer under a light microscope. The proportion of live sperm was ascertained by differential staining of fresh semen with eosin/nigrosin and examining it under a light microscope at 200x magnification. For each semen sample, two fields of about 100 sperm were examined and the average live and abnormal sperm counts computed and expressed as percentages of the cells counted.

Experimental design and data analysis: The experiment was a two-factor factorial experiment in a Randomized Complete Block (RCB) design with the levels of dietary DESM (0, 15, 30, 45 and 60%) (Treatments) and weeks of semen collection (1-6) as factors. The following model was used:

$$X_{ijk} = \mu + \alpha_i + \beta_j + \alpha\beta_{ij} + e_{ijk}$$

Where:

X_{ijk} = The observed value of each of the response variables (semen characteristic)
μ = The overall population mean
α_i = Observed effect of the dietary treatment (level of dietary DESM)
β_j = Effect of the jth week of semen collection
$\alpha\beta_{ij}$ = Effect of the interaction between dietary treatments and weeks
e_{ijk} = Random residual error due to experimentation

Data in the form of percentages were subjected to arc sine transformation prior to analysis. All data collected were analysed in line with procedures outlined by Steel and Torrie (1980). Means showing significant differences were separated using the Duncan's multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

The analysis of variance on the effects of varying levels of dietary DESM (Treatments) and time (weeks) of semen collection on the semen characteristics of the adult (20 week old) breeder cocks are presented in Table 2. Body weight, sperm motility, semen pH and percentage of live and abnormal sperm of semen collected from the breeders cocks were, in this study, unaffected ($p>0.05$) by variations in the levels of *Dacryodes edulis* seed meal (DESM) in their diets. This is an indication that replacement of as much as 60% of the dietary maize with DESM in male broiler breeder diets did not significantly alter these semen characteristics in the cocks.

However, the effect of dietary treatment on semen colour (or consistency), ejaculate volume and sperm concentration were significant ($p<0.05$) while the week of semen collection sperm had a highly significant influence ($p<0.01$) on ejaculate volume and sperm concentration. Body weight of the cocks also varied significantly with time of semen examination ($p<0.05$). There was no significant ($p>0.05$) treatment×time interaction effect on any of the semen characteristics.

Table 3 shows the effect of feeding varying levels of the test ingredient, *Dacryodes edulis* seed meal (DESM), on the mean body weight and the semen characteristics of the breeder males. Semen colour or consistency scores were significantly lower for cocks which received the control diets than for cocks on the 45 and 60% DESM diets. Cocks fed 15% DESM showed lower semen colour than those fed 30 or 60% DESM diets as well as sperm concentration of only those fed 60% DESM.

Table 2: The analysis of variance on the effect of varying levels of *Dacryodes edulis* seed meal (DESM) and time (weeks) on semen characteristics of breeder cocks

		Mean squares							
Source of variation	df	Body weight	Colour (consistency)	Motility (%)	pH	Volume (mL)	Concentration ($\times 10^6$)	Live sperm (%)	Abnormal sperm (%)
Total	59	-	-	-	-	-	-	-	-
Treatment	4	0.23^{ns}	1.72*	351.29^{ns}	0.15^{ns}	0.08**	12149.19**	83.84^{ns}	1.72^{ns}
Time	5	16.32*	4.64^{ns}	211.54^{ns}	0.20^{ns}	0.08**	2795.84**	114.74^{ns}	27.69^{ns}
Treatment×Time	20	1.49^{ns}	6.50*	146.60^{ns}	0.20^{ns}	0.01^{ns}	1523.41^{ns}	66.49^{ns}	21.66^{ns}
Error	30	1.62	4.11	152.50	0.21	0.10	1183.87	68.36	26.53

^{ns}Not significant, *Significant at p<0.05, **Highly significant at p<0.01, df: Degree of freedom

Table 3: The effect of dietary treatment on semen characteristics of the breeder cocks

	Levels of DESM inclusion (%)					
Parameters	0	15	30	45	60	Overall±SEM
Body weight (kg)	3.99^{a}	4.02^{a}	3.88^{a}	3.86^{a}	3.91^{a}	3.93±0.03
Colour (consistency)	2.14^{d}	2.32^{cd}	2.67^{ab}	2.58^{bc}	2.94^{a}	2.53±0.14
Motility (%)	58.44^{a}	63.51^{a}	55.94^{a}	68.26^{a}	67.36^{a}	62.70±2.42
pH	7.82^{a}	8.04^{a}	7.94^{a}	8.26^{a}	8.22^{a}	8.06±0.08
Volume (mL)	0.21^{b}	0.33^{a}	0.37^{a}	0.35^{a}	00.19^{b}	0.29±0.04
Concentration ($\times 10^6$)	46.45^{c}	59.04^{bc}	83.13^{b}	69.82^{bc}	129.02^{a}	77.49±14.23
Live sperm (%)	79.06^{a}	81.89^{a}	85.94^{a}	84.27^{a}	88.27^{a}	83.89±1.59
Abnormal sperm (%)	7.05^{a}	7.03^{a}	6.67^{a}	6.99^{a}	6.17^{a}	6.78±0.17

Means within a row with different superscripts are significantly different (p<0.01). SEM: Standard error of the means, DESM: *Dacryodes edulis* seed meal

Values varied from 2.14 for cocks on 0% dietary DESM to 2.94 in cocks which were fed the 60% DESM diets. The overall mean (2.53±0.14) indicated that semen from the cocks was generally milky/creamy in appearance. Mean semen pH was generally slightly alkaline and varied from 7.82 for cocks on the control treatment to 8.26 for cocks fed the 45% DESM diet. The overall mean was 8.06±0.08. Mean semen volume was significantly (p<0.01) higher in breeder cocks fed with 15, 30 and 45% DESM (0.33, 0.37 and 0.35 mL, respectively) than in those which received the control diet (0% DESM) (0.21 mL) and in those fed 60% DESM diet (0.19 mL). Sperm concentration ($\times 10^6$ mL^{-1}) generally increased significantly (p<0.01) as the level of DESM in the diets was increased. Sperm concentration for cocks on the control diet was, however, similar to those of cocks fed the 15 and 45% DESM diets but significantly lower than for cocks on the 30 and 60% dietary treatments.

Variations in mean body weight, semen colour, volume and pH, percent sperm motility and concentration, percent live sperm and percent abnormal sperm with time of semen collection are shown in Table 4. Mean body weight of the cocks for the 1st week of semen collection (4.63 kg) was similar to that of the second week (4.44 kg), but significantly higher than those of subsequent weeks (3.37-4.26 kg). The results showed a step wise decrease in body weight with progressive time of collection up to 4 weeks. Weekly variations in the mean semen colour (or consistency) scores were not significant (p>0.05).Values obtained varied from 2.23-2.70. Mean semen volume was significantly (p<0.01) higher during the second week of semen collection (43.06 mL) than in all other weeks (0.21-0.23 mL) except the 6th week (0.35). Mean sperm motility, semen pH, percent live sperm and percent abnormal sperm were unaffected by time of semen collection.

The significantly ($p<0.01$) higher mean ejaculate volume observed for cocks on the 15, 30 and 45% DESM diets compared to those on the control and 60% DESM diets, the generally higher semen consistency scores at the higher levels of DESM inclusion and the general increase in sperm concentration, percent sperm motility and percent live spermatozoa as the level of the test ingredient increased in the diets, show clearly that the test ingredient does not interfere with normal production and quality of semen in cocks and suggest that DESM may even have beneficial effects on sperm output and overall quality in broilers. These findings seem to confirm an earlier report (Oyeyemi *et al*., 2002) that sperm output and quality are influenced by the nutritional status of farm animals. Mean ejaculate volume was, in this study (0.29 mL), much higher than those reported for 8-9 months old Anak cocks by Odo *et al*. (2000) (0.01 mL) and Udeh and Mmereole (2005) (0.08 mL), but slightly lower than that obtained for Anak and Harco breeder males (0.34 mL) of similar ages by Gbadamosi and Egbunike (1999). The percent motility, live and abnormal sperm recorded in this work fall within the normal ranges of values recorded for local and exotic chickens in the humid tropics (Egbunike and Nkanga, 1999; Gbadamosi and Egbunike, 1999; Ezekwe and Machebe, 2004; Machebe and Ezekwe, 2005; Udeh and Mmereole, 2005).

Table 5 shows the linear correlation matrix for body weights and the semen characteristics of the breeder cocks. Non-significant ($p>0.05$) correlations existed between body weight and sperm motility (-0.22), semen pH (-0.53), semen volume (-0.32), sperm concentration (0.48) and percent

Table 4: Weekly variations in the mean semen characteristics of the breeder broiler cocks fed varying levels of *Dacryodes edulis* seed meal (DESM)

	Weeks						
Parameters	1	2	3	4	5	6	Overall±SEM
Body weight (kg)	4.63^{a}	4.44^{ab}	4.26^{b}	3.43^{c}	3.37^{c}	3.47^{c}	3.93±0.08
Colour (consistency)	2.39^{a}	2.63^{a}	2.70^{a}	2.68^{a}	2.56^{a}	2.23^{a}	2.53±0.08
Motility (%)	59.05^{a}	66.97^{a}	65.00^{a}	55.25^{a}	63.75^{a}	66.22^{a}	62.71±1.87
pH	8.17^{a}	7.02^{a}	8.24^{a}	8.28^{a}	7.25^{a}	9.29^{a}	8.04±0.33
Ejaculate volume (mL)	0.21^{d}	0.43^{a}	0.32^{bc}	0.23^{cd}	0.21^{d}	0.35^{ab}	0.29±0.04
Sperm concentration ($\times10^{6}$)	72.46^{bc}	104.45^{a}	56.83^{c}	88.88^{a}	73.30^{abc}	69.02^{bc}	77.49±6.83
Live sperm (%)	79.06^{a}	81.89^{a}	85.94^{a}	84.27^{a}	88.70^{a}	82.19^{a}	83.68±1.38
Abnormal sperm (%)	4.12^{a}	7.23^{a}	8.14^{a}	8.67^{a}	6.81^{a}	5.71^{a}	6.78±0.68

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

Table 5: Correlation^{+} matrix of body weight and semen quality characteristics of the breeder cocks

	Mean squares							
Parameters	Body weight (kg)	Colour (consistency)	Motility (%)	pH	Semen volume (mL)	Sperm concentration ($\times10^{6}$)	Live sperm (%)	Abnormal sperm (%)
Body weight (kg)	-	0.99**	-0.22	-0.53	-0.32	-0.48	-0.69	0.40
Colour (consistency)		-	0.41	0.68	-0.04	0.95*	0.93*	-0.89*
Motility (%)			-	0.91*	-0.17	0.40	0.36	-0.23
pH				-	0.08	0.59	0.65	-0.40
Ejaculate volume (mL)					-	-0.32	0.05	0.42
Sperm concentration ($\times10^{6}$)						-	0.93*	-0.98**
Live sperm (%)							-	0.86
Abnormal sperm (%)								-

*$p<0.05$; **$p<0.0$. $^{+}$Pearson's product-moment correlation coefficients

live sperm (-0.69). Body weight had a positive but non-significant ($p>0.05$) relationship with percent abnormal sperm (0.40) and a highly significant ($p<0.01$) positive correlation with semen consistency (0.99). Colour intensity had a positive significant relationship with the sperm concentration (0.95) and live sperm (0.93) but exhibited a significant negative correlation with abnormal spermatozoa (-0.89). Significant ($p<0.05$) positive correlations also existed between sperm motility and semen pH (0.91) and between sperm concentration and percent live sperm (0.93) while the relationship between sperm concentration and percent abnormal sperm was high but very significantly ($p<0.01$) negative (-0.98). Although all other relationships were non-significant, that between percent live and abnormal sperm was negatively high (-0.86).

The negative correlations observed between the body weights of the cocks and most of the semen characteristics agree with earlier reports by Reddy and Sadjadi (1990) and Udeh and Mmereole (2005) that as birds get heavier, semen quality declines. However, the results by Gbadamosi and Egbunike (1999) and Ezekwe and Machebe (2004) indicated that larger birds produce more semen has not been demonstrated in this study. This may be due to differences in location, nutrition, strain of birds used and climate amongst other factors.

CONCLUSION

Feeding breeder cocks diets containing as much as 30-45% DESM had no deleterious effect on mean semen colour or consistency scores, ejaculate volume and sperm concentration. It was concluded that DESM holds some promise as a possible substitute for maize in broiler breeder diets.

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