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Evaluation of semen quality of four strains of turkeys and parthenotes reared in the humid tropics for use in turkey breeding programmes

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Target Audience: *Farmers, Avian artificial Insemination personnel, Agricultural extension agents and Researchers.*

Abstract

A total of fifteen post-pubertal toms were used to determine the physical semen qualities of four varieties of turkeys and parthenotes (3 white local (WL); 3 black local (BL); 3 silver local (SL); 3 white Nicholas (WN) and 3 parthenotes (PT)) reared in humid tropics. The PT were from WL hens. The results indicated significant ($p<0.05$) effects of variety on semen volume, SV, normal sperm, NS, abnormal sperm, AS, sperm concentration, SC, total motile sperm, TMS and total sperm in ejaculate, TSE. The highest SV value of 0.43±0.03ml was recorded in WN and SL strains. WN and BL strains had the highest value of 98.50±0.50% in NS. SL and PT strains had the highest mean value of 4.50±0.50% in AS. The highest SC value of 3.55±0.05 x 10^9/ml was recorded in BL strain. BL strains had the highest value of 3.01±0.14 x 10^{12}/ml in TMS. BL strain had the highest value of 9.78±1.03 10^9 in TSE. It was concluded that the effect of strain was significant on the semen physical properties and that parthenotes were equally fecund and compared favourably with their white local parent strain and other strains and could be used in turkey breeding programmes.

Keywords: *Parthenogenesis; Parthenotes; Plumage colour; Strain; Turkeys*

Description of the Problem

Turkeys reared in the humid tropics can be classified by their genotype or plumage colours (1). A good number of plumage colours of turkey genotype exists which include black, bronze, brown, red and white (2) with black, bronze and white predominantly existing in the tropical environment (3).

Parthenotes are male turkeys arising from parthenogenesis. Parthenogenesis from the Greek word “parthenos”, meaning "virgin", and “genesis”, meaning "creation" is a natural form of asexual reproduction in which growth and development of embryos occur without fertilization. Parthenogenesis occurs very rarely in birds (4). Parthenogenesis, development from an unfertilized oocyte, has been documented in turkeys (5; 6).

Parthenogenesis in turkeys is an accidental form of parthenogenesis which is erroneously believed to be a form of facultative parthenogenesis and it appears to result from a conversion of haploid cells to diploid (7); most embryos produced in this way die early in development. Rarely, viable birds result from this process, and the rate at which this occurs in turkeys can be increased by selective breeding (7), however male turkeys produced from parthenogenesis exhibit smaller testes and reduced fertility (8).

Turkey parthenotes start as haploids, they then become diploid due to inhibition of cell division or cell fusion. In birds, females are the heterogametic sex (ZW) and males are the homogametic sex (ZZ), this is the opposite of mammals. WW parthenotes would not develop as this condition is not viable. Therefore, all

turkey parthenotes are males (9).

The reproductive problems of turkeys *inter alia* include unsuccessful natural mating due to size differences between toms and hens, parthenogenesis-a major cause of infertility in flocks, decrease in fertility within a breeding season partly due to genetic incompatibility, nutrition, disease, stress (10; 11) and other unknown factors.

Nevertheless, since the occurrence of parthenogenesis is inevitable in some strains of turkeys (6) and poses a threat to fertility, the study therefore sought to evaluate the semen quality of four strains of turkeys and parthenotes reared in the humid tropics to determine their fertility status and possible use in turkey breeding programmes.

Materials and Methods

Location: The study was carried out in the Poultry Unit of the Department of Animal Science Teaching and Research Farm, University of Nigeria, Nsukka. Geographical coordinates of Nsukka reveal that Nsukka lies within latitude 6°51'28"N and longitude 7°23'44"E and is 423 m above sea level (12). The climate of the study area is typically humid tropical, with relative humidity ranging from 55-85 % with mean daily temperature of 20° – 23.9°C and maximum ranges of 29.5°–34.9°C. The rainy season of Nsukka is from April to October and the dry season from November to March with annual rainfall range of 1600 – 1700 mm (12).

Experimental animals and management: The fifteen toms used for the study comprises 3 each of exotic strain (White Nicholas, WN), 3 local strains (black local, BL, white local, WL and silver local, SL) and parthenotes, PT. The toms were procured at day old from Bachelor Farms at Ibadan for the WN and Obasanjo Farms at Ogun State for the BL, WL and SL toms while the parthenotes were obtained from white local hens (6). Eggs from virgin white local hens were collected, incubated and hatched to produce parthenotes using the method described by (6). All the toms were fed 5% breeder's mash of their live body weights throughout the experimental period and water was given *ad libitum* throughout the period of the study. The birds were housed in well-ventilated netted pens according to types. Routine vaccinations and medications were administered. At 28 weeks old, semen collection commenced and was done once weekly for three weeks using the abdominal massage technique as described by (13) which was slightly modified in this experiment by tying the two legs of the toms and tying the rope to a peg on the wall to enable one collector in the process (14) as opposed to two persons in the method described above (Plate 1). Samples from the 3 toms in each of the strains and/or types were pooled and sent to the laboratory for analysis. Completely randomized design (CRD) was employed in the study. Data collected on semen quality traits were subjected to Analysis of Variance (ANOVA) using the Statistical Package for Social Sciences (SPSS for windows, V21.0; SPSS Inc., Chicago, IL, USA). Significantly different means were separated using Duncan's New Multiple Range Test (DNMRT) (15). Significance was determined at ($p<0.05$). To estimate the treatment effect, the following model was used:

$Y_{ij} = \mu + T_i + e_{ij}$

Where;

Y_{ij}= dependent variable;

μ = overall mean of the population;

T_i = mean effect of the ith treatment (j=5) and

e_{ij}= unexplained residual element assumed to be independent and normally distributed.

Results and Discussion: The seminal characteristics of the four strains of toms and parthenotes are shown in Table 1.

Turkey strains and parthenogenesis significantly ($P<0.05$) affected some of the

physical semen characteristics studied. Semen volume in the entire strains and Parthenotes studied ranged from 0.23±0.04 – 0.43±0.04 ml. The highest value of 0.43±0.04 ml was recorded in White Nicholas strains and the lowest value of 0.23±0.04 ml recorded White Local strain. The results agree with the findings of (16) who found a range of 0.28 – 0.45 ml for semen volume in two breeds of toms and (16) who asserted that breed differences exist in semen volume with respect to frequency of ejaculation.

There were no significant ($p>0.05$) differences in progressive motility, live sperm cells and dead sperm cells values. The findings partly disagree with those of (16) who found breed differences with respect to the above mentioned values at varying ejaculation frequencies.

Normal sperm cells values ranged from 96.50±0.71 – 98.50±0.71% with the highest value of 98.50±0.71% recorded in White Nicholas and Black Local strains and the lowest value of 95.50±0.71% recorded in Silver Local strain and Parthenotes toms. The findings partly agree with those of (16) and who found breed differences with respect to normal sperm at varying ejaculation frequencies and did not fall within the range reported by (17).

Plate 1: semen collection from toms by a single handler

Table 1: Semen physical properties of White Nicholas, Black Local, White Local, Silver Local and Parthenothes

Parameters/Strains	White Nicholas	Black	White	Silver	Parthenotes
SV (ml)	0.43±0.04[a]	0.28±0.04[b]	0.23±0.04[c]	0.43±0.04[a]	0.34±0.04[b]
PM (%)	85.00±7.07	85.00±7.07	95.00±7.07	85.00±7.07	94.00±7.07
LS (%)	99.50±0.71	99.50±0.71	99.50±0.71	99.50±0.71	99.00±0.71
DS (%)	0.50±0.71	0.50±0.71	0.50±0.71	0.50±0.71	1.00±0.71
NS (%)	98.50±0.71[a]	98.50±0.71[a]	96.50±0.71[ab]	95.50±0.71[b]	95.50±0.71[b]
AS (%)	1.50±0.71[b]	1.50±0.71[b]	3.50±0.71[ab]	4.50±0.71[a]	4.50±0.71[a]
SC (x10^9/ml)	1.55±0.07[b]	3.55±0.07[a]	1.75±0.07[b]	1.55±0.07[b]	1.65±0.07[b]
TMS (x10^{11}/ml)	1.32±0.05[b]	3.01±0.19[a]	1.66±0.06[b]	1.32±0.05[b]	1.55±0.05[b]
TSE (x10^9)	6.60±0.85[b]	9.78±1.45[a]	3.95±0.78[b]	6.60±0.85[b]	5.59±0.80[b]

[abc]Means with different superscripts in rows for different traits are significant (P<0.05). SV=semen volume; PM=progressive motility; LS=live sperm cells; DS=dead sperm cells; NS=normal sperm cells; AS=abnormal sperm cells; SC=sperm concentration; TMS=total motile sperm and TSE=total sperm in ejaculate.

Abnormal sperm cells values ranged from 1.50±0.71 – 4.50±0.71% with the highest value of 4.50±0.71% recorded in Silver Local strain and Parthenotes toms while the lowest value of 1.50±0.71% was recorded in White Nicholas and Black Local strains. The findings disagree with those of (17) who found no breed differences with respect to abnormal sperm cells values at different ejaculation frequencies.

Sperm concentration values ranged from 1.55±0.71 – 3.55±0.07 x 10^9/ml with the highest value of 3.55±0.07 x 10^9/ml recorded in Black Local strain and the lowest value of 1.55±0.07 x 10^9/ml recorded in White Nicholas strain. The values obtained here are partially in agreement with the findings of (16) who found breed differences in local and exotic toms at once bi-weekly and three times a week semen collection frequency.

Total Motile Sperm cells values ranged from 1.32±0.05 – 3.01±0.19 x 10^{11}/ml with the highest value of 3.01±0.19 x 10^{11}/ml recorded in Black Local strain and the lowest value of 1.32±0.05 x 10^{11}/ml recorded in White Nicholas and Silver Local strains.

Total sperm in ejaculate values ranged from 3.95±0.78–9.78±1.45 x 10^9 with the highest value of 9.78±1.45 x 10^9 recorded in Black Local strain and the lowest value of 3.95±0.78 x 10^9 recorded in White Local strain. The findings agree with the findings of (16) who reported that breed differences exist with respect to total sperm in ejaculate.

Conclusion and Applications

1. Variations in the genetic make-up of the turkey as influenced by the plumage colour accounted for the observed differences in physical semen quality characteristics in the three strains. The high values in semen qualities observed in Black Local toms showed that they have higher reproductive potentials in Nigeria and the values for Parthenotes show that they are equally fecund.
2. The use of parthenote semen should only be limited to white and black local hens as this may increase the rate of successful parthenogenesis vis-à-vis the economic gains in these strains.
3. In White Nicholas and Silver Local hens, the use of parthenote semen may increase the rate of embryonic mortalities (14).
4. Addressing animal welfare issues is of utmost importance here with respect to the method of semen collection used. Both methods (13) and (14) stress the animals

alike but (13) is costlier and the economic point of view should come into play especially in developing countries. The reduced cost will increase adoption of the technology among farmers.

5. It was therefore concluded that both Parthenotes and parent toms as well as other strains possess high quality semen and fertility status and can be used in turkey breeding programmes.

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