



EFFECT OF FREQUENCY OF ARTIFICIAL INSEMINATION ON REPRODUCTIVE PERFORMANCE OF NIGERIAN LOCAL CHICKEN

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ABSTRACT

The Nigerian local chicken (NLC) are being selected for fast growth and improved body size, two important traits in breed utilization for commercial meat production. These traits are however negatively correlated with reproductive trait. Artificial insemination (AI) could be successfully deployed to overcome this problem as currently done in turkey breeding and could also be used to maintain pedigreed mating. This study evaluated the effects of AI frequency on reproductive performance of NLC. Seventy-two birds (aged 33 weeks) comprising 12 cocks and 60 hens were used in a 1:5 mating ratio. The birds were kept in battery cages and deep litter for a period of eight weeks. They were randomly distributed into four treatment groups of varied insemination frequencies: Natural mating (Control); AI twice weekly; AI once weekly; and AI once in two weeks. For two weeks prior to mating, the cocks' body weight and sperm characteristics (semen volume, sperm concentration and motility and percentage active sperm cells) were determined. A total of 2,400 fertile eggs were collected from the treatment groups and set in incubator to evaluate the percentage day 12 fertility, percentage day 18 live germs and hatchability of fertile eggs. Data were analyzed using one – way ANOVA and Chi-square (SPSS, 23). There was no significant difference in the body weight and sperm characteristics between the treatment groups. There was however significant ($p < 0.05$) effect of insemination frequency on fertility of eggs from weeks 1 to 7. Birds inseminated twice weekly had the highest mean fertility (90.85%) while birds inseminated once in two weeks had the lowest fertility (58.34%). The effect of insemination frequency on Day 18 percent live germs was not significant. Insemination frequency affected hatchability significantly ($p < 0.05$) in 6 out of 8 weeks. Bird inseminated once weekly had the highest hatchability (72.8%), while birds inseminated once in 2 weeks had the lowest hatchability (57.0%). The study showed that inseminating birds twice weekly improve fertility of eggs while insemination frequency of once weekly enhance hatchability. Inseminating birds twice weekly is hereby recommended for enhancing fertility in commercial production of Nigerian Local chicken.

Key words: Chickens, AI, Semen, Fertility, Hatchability

Introduction

Artificial Insemination (AI) is the manual transfer of semen into the female's vagina (Bakst and Dymond, 2013). As a breeding technique in poultry, AI is proposed to increase mating ratio, enhance utilization of genetically proven older or injured male and eliminate poor fertility associated with preferential mating (Kharayat *et al.*, 2016). Solving such reproductive problems will ensure effective selection of males as the increased selection pressure on economic traits in male leads to greater genetic advancement per generation and better management of breeding stock (Leeson and Summer, 2009; Kharayat *et al.*, 2016).

The aim of AI is to produce a succession of fertile eggs between successive inseminations (Bakst and Dymond, 2013) without jeopardizing fertility. Spermatozoa introduced into the vagina are stored in the utero vagina junction (UVJ) and sperm storage tubules (SSTs). As eggs are ovulated, individual sperm are released from SSTs, transported to the anterior end of the oviduct and fertilized the ovum (Bakst, 2011; Getachew, 2016). The storage of sperm in the avian female UVJ and SSTs are however breed and species specific (Bakst and Dymond,



2013). AI is applied extensively in commercial turkey production to solve fertility problems related to heavy weight and broad breasted toms (Bakst and Dymond, 2013; Kharayat *et al.*, 2016). Although, the use of AI in chicken has not been fully adopted due to significant labor cost associated with large numbers of breeders that need to be inseminated weekly (Kharayat *et al.*, 2016), its use has been reported in pure line breeding stock and in caged dwarf broiler breeders (Leeson and Summer, 2009). The currently ongoing improvement efforts aimed at introducing commercial local chicken breeds for meat production in Nigeria (Adebambo *et al.*, 2011) may depend on AI in successfully maintaining pedigreed mating (Kharayat *et al.*, 2016). Reproductive success in poultry is assessed through fertility and hatchability of eggs which are two major parameters that influence the demand for day old chicks (Ndofor – Foleng *et al.*, 2015). While fertility is defined as the percentage of incubated eggs that become fertile, hatchability is defined as the percentage of fertile eggs that is eventually hatched (Ndofor – Foleng *et al.*, 2015).

The insemination interval for AI is 14 days in turkey and 7 days in broiler chicken (Kharayat *et al.*, 2016). There is need to provide empirical data to determine if the same insemination interval could be adopted in Nigerian local chicken. This will ensure reproductive success is not negatively impacted as AI is utilized in maintenance of pedigreed mating as improvement efforts progress. This study therefore aimed at assessing the effect of varied artificial insemination frequency (interval) on egg fertility and hatchability in the Nigerian local chicken.

MATERIALS AND METHODS

Experimental site

The experiment was conducted at the poultry unit of Teaching and Research Farm, Kwara State University, Malete, Kwara State, Nigeria. The University is located in the North Central geopolitical zone of Nigeria and lies on geographical coordinates 8° 42' 0" North 4° 28' 0" East.

Experimental Birds and Management

Seventy-two, 33 weeks old Nigeria Local chickens comprising of 12 males and 60 females were randomly selected from the stock of 300 day old chicks purchased at the poultry unit of the Federal University of Agriculture, Abeokuta. The birds were used for this experiment in a mating ratio of 1:5 after been raised to sexual maturity on standard management and diet. They were divided randomly into four treatment groups with three replicates each based on the frequency of artificial insemination resulting in 3 males and 15 females per treatment group which are Group 1: Natural mating on deep litter (Control); Group 2: Artificial insemination twice weekly; Group 3: Artificial insemination once weekly; and Group 4: Artificial insemination once in two weeks. All the birds in the treatment group 2 – 4 were kept separately in the battery cages throughout the experimental period while the birds in the control group were kept on deep litter in 3 mating pens to permit natural mating between the cocks and the assigned females. The birds were identified using wing tags and cage identifications. Females birds were fed with layers mash (16.50% Crude Protein and 2500 Kcal/Kg energy) and the cocks were fed with breeder ration (13.35% Crude Protein and 2737 Kcal/Kg energy). Semen was collected through abdominal massage (Burrows and Quinns, 1937) in a sterilized container and evaluated based on the methods of Peters *et al.*, 2008 for semen volume, sperm cell concentration and sperm motility to access the reproductive parameters of the cocks two weeks prior to insemination of the assigned females in each experimental group. The body weight of the cocks were also determined. Semen was collected from the assigned cocks in each treatment group, pooled into a 1ml syringe and 0.1ml of un-extended semen was inserted into the everted oviduct of each hen in the group. For the first insemination, birds were inseminated on two consecutive days; thereafter first egg collection was commenced after 48 hours. A total of 2,400 eggs were collected (5 eggs per hen per week), marked according to the maternal and sire



identification, sorted and stored for five days prior to setting in incubator (Kge[®] Incubator, Nigeria) after fumigation. Candling was done on 12th day for fertility and 18th day to determine the ratio of live to dead embryo. Only the fertile eggs were transferred to the hatcher on the 19th day. The number of fertile eggs, live embryo and number of hatched chicks were counted and recorded. Egg number was recorded as the total number of eggs laid by the hens within each treatment group during the experimental period of eight weeks. Collected data were expressed in percentage as follows:

$$\begin{aligned}\text{Percentage Fertility} &= \frac{\text{Number of fertile eggs}}{\text{Number of eggs set}} \times 100 \\ \text{Percentage Hatchability} &= \frac{\text{Number of Chicks hatched}}{\text{Number of fertile eggs}} \times 100 \\ \text{Percentage Live germ} &= \frac{\text{Number of live germ}}{\text{Number of fertile eggs}} \times 100\end{aligned}$$

Statistical analysis

Data collected were analyzed using one – way ANOVA and chi-square (χ^2) analysis Test of Independence at 5% significance level using version 23 of SPSS IBM 2013. Duncan Multiple range test was used to compare the means and 2 x 2 contingency table was used to determine significant difference in the chi-square analysis (Beasley and Schumacker, 1995). The following model was adopted for the study: $Y_{ij} = \mu + p_i + e_{ij}$

Where Y_{ij} = individual observation, μ = Overall mean, p_i = fixed effect of i^{th} insemination frequency and e_{ij} = experimental errors which is evenly distributed.

RESULTS AND DISCUSSION

The preliminary analysis of the body weight and semen characteristics of the cockerels used in the study for two weeks prior to the artificial insemination of the birds indicated that there was no significant difference ($p > 0.05$) in parameters evaluated between the control group (natural mating) and the various insemination frequency groups. There was also no difference among the insemination frequency groups (Table 1). The ejaculate (semen) volume and percent motile (active) sperm cells were within the range of 0.2 – 0.5 and 60 – 80 stated by Getachew (2016) for cockerels. The sperm cell concentration was lower than the range of 3,000 – 7,000 x 10⁶/ml reported by Peters *et al.* (2008), Churchill *et al.* (2014) and Getachew (2016). It was however higher than the value of 750 x 10⁶/ml observed by Machal and Krivanek (2002) for birds within the age range of 28 – 35 weeks which was similar to the age of birds used in the current study. The non-significant difference in the preliminary evaluation of semen parameters revealed that there were no variation in the reproductive potentials of the cocks prior to their utilization in the study hence they could not be implicated in variation of egg fertility among the insemination frequency groups.

The 12th day fertility of eggs collected from Nigerian Local Chicken hens inseminated at varied frequency (Table 2) was significantly different ($p < 0.05$) for 7 weeks out of the 8 weeks study period. The fertility of eggs from birds artificially inseminated twice weekly were similar to the fertility of eggs collected from birds subjected to natural mating (control) throughout the experimental period except at week 4 where birds inseminated twice weekly had significantly ($p < 0.05$) higher fertility than the control. The birds inseminated once in two weeks had the lowest significant ($p < 0.05$) fertility throughout the 8 - weeks study period except at the first and the last week of insemination when they had similar fertility with the control (Table 2). The variation in fertility among the treatment groups may be due to survival of semen in the utero-vagina junction (UVJ) in poultry. The average weekly percentage fertility of 87.51% recorded for the control (natural mating) and 90.85% for birds subjected to AI twice weekly respectively



in this study were higher than the value of 83.7% reported by Ajayi *et al.* (2008) for different genotypes of indigenous chickens. The value of 74.66% weekly percentage fertility for birds inseminated once weekly and 58.34% for birds inseminated once in two weeks were however lower than the value of 83.7% reported by Ajayi *et al.* (2008) and 76% reported by Fayeye *et al.* (2005) for Fulani ecotype chicken. The number of sperm storage tubules (SSTs) available in the UVJs in the chicken estimated at 5,000 – 13,000 is associated with duration of sperm storage and hence fertility. Selection for high fertility after several generations in chicken hen was shown to increase the number of SSTs in selected birds as compared against the unselected birds (Bakst and Dymond, 2013). Although, chicken can store sperm for up to three weeks and still lay fertile eggs (Bakst and Dymond, 2013), the number of viable sperm cells in the oviduct, progressively been depleted if not replenish by subsequent insemination, have been shown to affect the percentage fertility of eggs (Leeson and Summer, 2009). The present study indicates that the depletion of sperm cells in the oviduct up to 14 days results in significant reduction of egg fertility in Nigerian local chicken. Insemination twice weekly however enhance fertility significantly.

The frequency of insemination significantly ($p < 0.05$) affect the day 18 percentage live germs at the second, third and eight week (Table 3). The birds inseminated twice weekly, once weekly and those subjected to natural mating (control) had similar percentage day 18 live germs. The birds inseminated once in two weeks, however had significantly ($p < 0.05$) lowest day 18 percentage live germs (Table 3). This result confirms the report of Eslick and McDaniel (1992) that there is negative effect of minimal number of sperm in the female oviduct on hatch of fertile eggs due to early dead embryo. The birds inseminated once in two weeks in this study could have had depleted number of viable sperm cells in the oviduct compared to the other more frequent insemination groups.

There was significant ($p < 0.05$) effect of insemination frequency on the hatchability of eggs throughout the study period except at week 4 and 6 (Table 4). Birds inseminated once weekly had the highest hatchability at week 1, 2 and 7 while birds inseminated once in two weeks had the lowest hatchability throughout the study period except at the 2nd and 7th week when the control had the lowest hatchability due to increased incidence of egg eating habit (Table 4). The average weekly percentage hatchability reported in this study for the birds inseminated once weekly (72.8%) conform to established level in literature for B-alpha chicken (Akanni *et al.*, 2008). The least percentage hatchability was reported among the birds inseminated once in two weeks (57.02%). The low hatchability recorded for the once in two weeks treatment group might be due to minimal viable sperm cells in the oviduct of the birds (Eslick and McDaniel, 1992) which led to low fertility. Low fertility of eggs correlates with low hatchability (Leeson and Summer, 2009).

CONCLUSION

The study revealed that the varied frequency of insemination had significant effect on Day 12 fertility, Day 18 live embryo and hatchability of Nigerian local chicken. The study concluded that the birds inseminated at frequencies of twice weekly and once weekly had significantly higher fertility and hatchability when compared to the birds inseminated at the frequency of once in 2 weeks. It is therefore recommended that Nigerian local chicken hen should be inseminated twice weekly to obtain optimal egg fertility in artificial insemination schemes.

REFERENCES



- Adebambo, A. O., Ikeobi, C. O. N., Ozoje, M. O., Oduguwa, O. O., and Adebambo, O. A. (2011). Combining abilities of growth traits among pure and crossbred meat type chickens. *Arch. Zootec.* 60 (232), 953 – 963.
- Ajayi, F. O., Agaviezor, B. O., Torukuru, S. (2008). Fertility and Hatchability of Indigenous Chicken as influenced by Major Genes in The High Rainforest Zone of Nigeria 13th Annual Conference of the Animal Science Association of Nigeria. Sept. 15-19. 81- 83
- Akanni K.T., Peters S. O., Adebambo, O. A., Omoare A. M., Adekunle, A. A.(2008). Reproductive Performance of Local, Nera Black and B-Alpha Improved Indigenous *Animal Production* 7– 9.
- Bakst, M. R. (2011) Physiology and Endocrinology symposium: Role of the oviduct in maintaining sustained fertility in hens. *Journal of Animal Science*, 89 (5) 1323 -9
- Bakst, M. R., and Dymond, J. S. (2013) Artificial insemination in poultry. *Intech* <http://dx.doi.org/10.5772/54918>
- Beasley, T. M., and Schumacker, R. E. (1995). Multiple Regression Approach to Analyzing Contingency Tables: Post Hoc and Planned Comparison procedures. *The Journal of Experimental Education*, 64 (1), 79 – 93.
- Slick, M. L and McDaniel, G. R. (1992) interrelationships between fertility and hatchability of eggs from broiler hens. *Journal of Applied Poultry Resources.* (1), 156 -159
- Fayeye, T. R., Adeshiyan, A. B., and Olugbami, A. A. (2005). Egg traits, hatchability and early growth performance of the Fulani ecotype chicken. *Livestock Research for Rural Development.* 17 (8).
- Getachew, T. (2016). A Review of Artificial Insemination in Poultry. *World's Veterinary Journal* 6 (1), 25 – 33.
- Kharayat, N. S., Chaudhary, G. R., Katiyar, R., Balmurugan, B., Patel, M., Uniyal, S., Raza, M., and Mishra G. K. (2016).Significance of Artificial Insemination in Poultry.*Research & Reviews: Journal of Veterinary Science and Technology*ISSN: 2319–3441(online), ISSN: 2349-3690(print) 5, (1)
- Leeson, S., and Summers, J. D. (2009). *Broiler Breeder Production*. England, Nottingham University Press.
- Machal, L., and Krivanek, I. (2002). Indicators of semen quality of roosters of three parental layer lines and specific conductivity of the semen. *Acta Vet. Brno*, 71, 109-116.
- Ndofor-Foleng, H. M., Oleforuh-Okoleh, V., Musongong, G. A., Ohageni, J. and Duru, U. E. (2015) Evaluation of growth and reproductive traits of Nigerian local chicken and exotic chicken *Indian Journal of Animal Resources* 49 (2) 155-160 doi:10.5958/0976-0555.2015.00046
- Peters, S.O., Ilori, B.M., Ozoje, M.O., Ikeobi C.O.N. and Adebambo, O.A. (2008). Gene segregation effects of fertility and hatchability of pure and cross bred chicken genotypes in humid tropics. *International Journal of Animal Science*, 710, 954-958.

Table 1: The Body Weight and Semen Characteristics of Nigerian Local Cocks assigned to various Artificial Insemination Frequencies



Group	Week	Parameters				
		Body Weight (Kg)	Sperm Motility Score (0 – 4)	Semen Volume (ml)	Sperm Count ($\times 10^6/\text{ml}$)	Active Sperm Cells (%)
1	1	2.17 $\pm$ 0.18	3.33 $\pm$ 0.67	0.33 $\pm$ 0.03	797.92 $\pm$ 4.17	60 $\pm$ 10
2		2.3 $\pm$ 0.15	4 $\pm$ 0	0.43 $\pm$ 0.03	839.58 $\pm$ 48.99	73.33 $\pm$ 6.67
3		2.5 $\pm$ 0.08	4 $\pm$ 0	0.5 $\pm$ 0.16	793.75 $\pm$ 112.27	70 $\pm$ 8.16
4		2.5 $\pm$ 0.06	4 $\pm$ 0	0.43 $\pm$ 0.13	891.67 $\pm$ 126.05	70 $\pm$ 5.77
1	2	NA	3 $\pm$ 0	0.43 $\pm$ 0.12	1337.5 $\pm$ 285.14	50 $\pm$ 0
2		NA	3.33 $\pm$ 0.33	0.47 $\pm$ 0.03	1116.67 $\pm$ 221.92	60 $\pm$ 10
3		NA	4 $\pm$ 0	0.4 $\pm$ 0.08	1071.88 $\pm$ 2.55	75 $\pm$ 4.08
4		NA	3.33 $\pm$ 0.67	0.37 $\pm$ 0.07	1464.58 $\pm$ 392.71	63.33 $\pm$ 12.02

Data are presented as $\pm$ SEM. Group 1 = Natural mating (Control group); Group 2 = Artificial Insemination twice in one week; Group 3 = Artificial Insemination once in one week; Group 4 = Artificial Insemination once in two weeks. Values within the column with different superscript ^{abc} are significantly ($p < 0.05$) different.

Table 2: The effect of Frequency of Artificial Insemination on Day 12 Fertility in Nigerian Local Chicken

AI Frequency	Weeks							
	1	2	3	4	5	6	7	8
Natural Mating (Control)	69 ^{ab} (92.0)	68 ^{ab} (90.7)	72 ^a (96.0)	62 ^b (82.7)	65 ^a (86.7)	65 ^{ab} (86.7)	63 ^{ab} (84.0)	61 (81.3)
Twice in One week	63 ^{bc} (84.0)	72 ^a (96.0)	74 ^a (98.7)	71 ^a (94.7)	62 ^a (82.7)	70 ^a (93.3)	65 ^a (86.7)	68 (90.7)
Once in One week	57 ^c (76.0)	63 ^b (84.0)	37 ^b (49.3)	48 ^c (64.0)	62 ^a (82.7)	61 ^b (81.3)	53 ^b (70.7)	67 (89.3)
Once in Two weeks	72 ^a (96.0)	62 ^b (82.7)	30 ^b (40.0)	28 ^d (37.3)	28 ^b (37.3)	35 ^c (46.7)	33 ^c (44.0)	62 (82.7)
p - value	< 0.01	0.04	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.25
χ^2	15.65	8.38	102.75	66.42	60.19	55.02	41.93	4.1

AI = Artificial Insemination. Data are presented as counts with percentages in parenthesis. Counts within the same column with different superscripts ^{abc} are significantly different based on residual ≥ 2 in a 2 x 2 contingency table.

Table 3: The effect of Frequency of Artificial Insemination on Day 18 Live Germs in Nigerian Local Chicken

AI Frequency	Weeks							
	1	2	3	4	5	6	7	8
Natural Mating (Control)	65 (94.2)	65 (95.6) ^a	72 (100) ^a	55 (88.7)	54 (83.1)	65 (100)	63 (100)	48 (78.7) ^{ab}
Twice in One week	56 (88.9)	68 (94.4) ^a	74 (100) ^a	62 (87.3)	55 (88.7)	68 (97.1)	64 (98.5)	60 (89.6) ^a
Once in One week	57 (100)	58 (92.1) ^a	37 (100) ^a	38 (79.2)	51 (83.6)	61 (100)	53 (100)	60 (88.2) ^a
Once in Two weeks	69 (95.8)	41 (66.1) ^b	25 (83.3) ^b	22 (78.6)	25 (89.3)	33 (94.3)	32 (97.0)	43 (69.4) ^b
p - value	0.06	< 0.01	< 0.01	0.38	0.72	0.11	0.41	0.01
χ^2	7.56	34.44	31.23	3.09	1.33	6	2.92	11.44

AI = Artificial Insemination. Data are presented as counts with percentages in parenthesis. Counts within the same column with different superscripts ^{abc} are significantly different based on residual ≥ 2 in a 2 x 2 contingency table.

Table 4: The effect of Frequency of Artificial Insemination on Hatchability in Nigerian Local Chicken



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AI Frequency	Weeks							
	1	2	3	4	5	6	7	8
Natural Mating (Control)	43 (62.3) ^{bc}	26 (38.2) ^b	67 (93.1) ^a	49 (79.0)	54 (83.1) ^a	58 (89.2)	10 (15.9) ^c	40 (65.6) ^a
Twice in One week	49 (77.8) ^{ab}	49 (68.1) ^a	63 (85.1) ^{ab}	45 (63.4)	30 (48.4) ^b	51 (72.9)	30 (46.2) ^b	42 (61.8) ^a
Once in One week	45 (78.9) ^a	44 (69.8) ^a	29 (78.4) ^{bc}	33 (68.8)	34 (55.7) ^b	49 (80.3)	41 (77.4) ^a	49 (73.1) ^a
Once in Two weeks	44 (61.1) ^c	24 (38.7) ^b	20 (66.7) ^c	18 (64.3)	18 (64.3) ^b	28 (80.0)	14 (42.4) ^b	24 (38.7) ^b
p - value	0.04	< 0.01	< 0.01	0.23	< 0.01	0.12	< 0.01	< 0.01
χ^2	8.48	24.73	12.06	4.27	18.31	5.77	44.22	17.41

AI = Artificial Insemination. Data are presented as counts with percentages in parenthesis. Counts within the same column with different superscripts ^{abc} are significantly different based on residual ≥ 2 in a 2 x 2 contingency table.