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Effect of Different Management Systems and Ejaculation Frequencies on Fertility and Hatchability of Turkey Eggs

***[1]Ezike, J.C., [1]Ezea, J., [1]Nosike, R.J., [1]Nathaniel, J., [2]Machebe, S.N. and [2]Ugwu, S.O.C.**

[1]Department of Animal Breeding and Physiology, Michael Okpara University of Agriculture, Umudike
[2]Department of Animal Science, University of Nigeria, Nsukka
Corresponding Author's email: ezikejohnson96@gmail.com

Abstract
A total of 72 local turkeys comprising 24 Toms and 4 hens were used for the study. The males were randomly divided into two groups; M_1 and M_2. Group M_1 males were intensively managed and fed 17% CP and 12.6 MJ/kg Metabolizable energy breeder diet. Group M_2 males were semi-intensively managed and subjected to free range management and given concentrates. The males in both groups were randomly divided into four groups and subjected to four ejaculation frequencies/treatments (once, twice, three times and four times) per week using abdominal massage technique. A total of 729 eggs were incubated, candled and analyzed for fertility and hatchability. The data obtained were subjected to analysis of variance in a 2x4 factorial arrangement in a Completely Randomized Design. Significant means were separated using Duncan's option of SPSS. The results obtained showed significant ($p < 0.05$) effect of ejaculation frequency and management system on fertility and hatchability in all the parameters measured. The number of fertile eggs (NF) was significantly ($P< 0.05$) affected by ejaculation frequency and management system. Once and twice per week ejaculation frequency produced the highest number of fertile eggs under M_2. The number of infertile eggs was significantly ($P<0.05$) affected by ejaculation frequency, increasing with increase in ejaculation frequency in both management systems. Similarly, the number of early dead-embryo was significantly ($P<0.05$) affected by ejaculation frequency. Once per week ejaculation had the highest early dead embryo in both management systems. Percentage fertility ranged from 71 .01 I; 2.65% to 92.18 ± 21.18% in both management systems. Out of a number of 929 eggs incubated, 614 eggs were fertile. Percentage hatchability ranged from 85.1 1 ± 4.20%o to 100 ± 0.00 in both management systems. Therefore, two times per week ejaculation was ideal local forms used for AI, and both management systems could be used for rearing breeder toms.

Keywords: Management, turkey, ejaculation frequency, fertility and hatchability

Introduction

Among birds, mating habits vary from monogamous to promiscuity. Studies with chickens revealed that cockerels may mate up to 30 times in a day but more than 50% of the matings are not associated with release of semen (Burke, 1984). Carte and Leighton (1968) reported that turkey hens displayed an intense sex drive just prior to reaching sexual maturity, during which time the reproductive efficiency of toms were very low. Carte and Leighton (1969) reported preferential mating in rotated male mating scheme. It has also been reported that hens show a reduction in sex drive following an incomplete mating which is comparable to that following a complete mating. Trutting activity has been observed in females in which case some hens court other hens and actually complete mating act with concomitant loss of libido. In toms, partial completion of mating act without transfer of semen to the hen resulting in periods of sexual refractoriness has been reported (Burke, 1984).

Research reports on the number of times toms can mate in a day with or without transfer of semen to the hen is apparently lacking. However, ejaculation frequencies have been used to simulate libido in toms and to study the quality characteristics of successive ejaculates to predict the fertilizing abilities of the spermatozoa in the ejaculate in vitro. More often than not, on-farm evaluation of the results of such in-vitro studies is lacking. Also experiments on ejaculation frequencies are usually conducted under intensive management system only on the toms. Research reports on fertility and hatchability of spermatozoa of toms subjected to various ejaculation frequencies under semi-intensive management system are lacking. Semi-intensive management system is now a more sustainable and economically viable production option adopted by most small and medium scale turkey farmers in rural and peri-

urban areas, where extensive production has been banned due to the destructive feeding habit of turkeys. Also, shrinking agricultural lands due to urbanization has equally forced people to cultivate arable crops around residential quarters, making extensive production of turkeys socially unjust and unacceptable because of their gregarious feedings habits. Similarly, the ever increasing costs of poultry feed and feed stuffs have continued to knock-off many turkey farmers, making intensive production unattractive due to high cost of production given the current economic situation.

There is therefore need to reappraise our production systems with emphasis on the semi – intensive management system so as to maximize production in order to meet our need for improved daily animal protein intake. This study was designed not only to compare the fertility and hatchability results of the two major systems of rearing turkeys in the study location to provide useful information to farmers who practice artificial insemination, but also to provide an on-farm result of the fertilizing capacity of spermatozoa of breeder toms subjected to various ejaculation frequencies.

***Keywords**: Turkey, management, frequency, ejaculation, semen, artificial insemination, fertility and hatchability*

Materials and Methods

Study site

The study was carried out at the Poultry Unit, Department of Animal Science Teaching and Research Farm, University of Nigeria, Nsukka. Nsukka lies in the Derived Savannah region, and is located on longitude 6^0 25′N and Latitude 7^0 24′E, at an altitude of 430m above sea level. The climate is a typical humid tropical type with a relative humidity range of 56.01 –4 103.83%. Average diurnal minimum temperature ranges from 22°C - 24.7°C with the average maximum temperature ranges between 33°C - 37°C. Annual rainfall ranges from 1567.05mm to 1846.98mm (Meteorological Centre, Crop Science Department, University of Nigeria, Nsukka, 2009. Unpublished).

Experimental birds and management

A total of 72 mature local turkeys comprising 24 toms and 48 hens were used for the study. The turkeys were sourced from a poultry farm in Ekwuluobia, Anambara State, Nigeria at 8 weeks of age. The poults were raised together in well-ventilated netted deep litter pen and fed growers' mash containing 15% CP and 2670 KcalME/kg with clean fresh water *ad libitum* up to 20 weeks of age. Routine vaccination and medications were observed. At this age, the males were randomly divided into two management groups - intensive (M_1) and semi-intensive (M_2) respectively with 12 males per group and replicated three times with 4 Toms per replicate. All the males were selected, wing tagged and distributed into four ejaculation frequencies/treatments (once - E_1, twice- E_2, three times - E_3 and four times- E_4 per week). The M_2 males were thereafter withdrawn from the grower's diet and subjected to free range management in a fenced area of the farm and fed supplements made up of maize chaff and PKC in feeders positioned at strategic locations in the run. They were fed in the morning and in the evening until the end of the experiment. Group M_1 toms continued with the growers' diet up to twenty six weeks of age and thereafter placed on a breeder diet containing 17% CP and 12.16 MJ/kg Metaboliable energy diets. The hens were separated from the group M_1 males on the eighteenth week and fed breeder diet as the group M_1 toms until the end of the experiment. The hens were wing-tagged and randomly divided into management groups - M_1 and M_2 corresponding to those of the males with 24 hens per treatment and replicated 3 times with 8 hens per replicate. The hens were randomly selected and placed individually in a well ventilated netted floor pen of 5ft x 5ft dimension with high absorbed litter materials. Trap egg nests were provided in each pen. Fertile eggs were collected daily for 24 weeks. The experimental diets are shown in Table 1.

Semen collection

The toms were ejaculated accordingly (once, twice, three and four times) weekly using abdominal massage technique (Burrows and Quinn, 1937). A total of sixteen toms were selected from both M_1 M_2 based on high score for semen quality characteristics with 8 toms per treatment and two toms per replicate.

Artificial insemination

The hens were sexually stimulated by venting (Hafez, 1984). Semen was pooled from each donor male with a 5ml beaker and maintained warm in an improvised incubator kit. All the syringes and the diluents were maintained warm in the incubation kit. An aliquot (0.2ml) of fresh semen, collected from each donor male was drawn with a syringe and added directly to 2ml warm physiological saline in a 5ml beaker. The semen with diluents was thoroughly mixed by gentle swirling. 0.25ml of the diluted semen containing 20 million spermatozoa was deposited in the everted vagina of each female within 30 minutes of collection using a clean and dry 1ml tuberculine syringe. All the hens were inseminated 3 times weekly for two weeks prior to onset of egg production and thereafter twice weekly throughout the experimental period.

Egg collection, candling and hatching

Eggs were collected daily from each treatment group, properly identified, sorted and stored in egg crates at room temperature. The eggs were set for incubation every four days and incubated with a locally fabricated kerosene incubator. The set eggs were candled on the eighteenth day of incubation. After candling and at the end of incubation period of 21 days, egg break-out was carried out and, eggs classified as infertile, fertile, early dead embryos, late dead embryos and hatched. All dead embryos were considered fertile. The fertility and hatchability of the eggs were calculated and recorded in percentages as follows:

$$\% \text{ Fertility} = \frac{\text{Number of fertile eggs}}{\text{Number of eggs set}} \times \frac{100}{1}$$

$$\% \text{ hatchablity} = \frac{\text{Number of poults hatched}}{\text{Number of eggs set}} \times \frac{100}{1}$$

Experimental design and Statistical analysis

The experiment was carried out in a 2 x 4 factorial arrangement in a Completely Randomized Design (CRD). The data obtained were subjected to Analysis of Variance using SPSS. Significant Means were separated using Duncan (1955) New Multiple Range Test option of SPSS. The statistical model used for data collection is as shown below:

$$Y_{ijk} = U + T_{ii} + (T+)_{ij} + e_{ijk}$$

Where:

Y_{ijk}= Individual observation of independent variables.

U= Overall mean

T_i=Effect of management System on the i^{th} individual male

α = Effect of ejaculation frequency on the j^{th} individual male.

$(T+)_{ij}$ =Interaction effect of management system and ejaculation frequency on the i^{th} and j^{th} individual male

e_{ijk} = Random error associated with individual observation.

Results and Discussion

The effect of management system and ejaculation frequency on the fertilizing capacity of local turkey semen is shown in Table 2. The result of the study indicated that management system (M) and ejaculation frequency (E) significantly ($P < 0.05$) affected the number of fertile (NF) eggs. NF decreased with increasing ejaculation frequency in both intensive (M_1) and semi-intensive (M_2) management systems. NF was significantly ($P < 0.05$) better in M_2 than M_1 across the four frequencies of ejaculation. Twice per week (E_2) ejaculation frequency gave the highest mean values for NF (11.13 ± 1.20 and 10.13 ± 0.9) for NF under M_2 and M_1 respectively. The difference in the fertility results obtained in this study could be attributed to the beneficial effects of the fertility enhancing phytochemicals in the forages consumed by the Toms under semi-intensive management system. This is in agreement with the report of Durape (2007) who used phytochemical rejuvenators to increase fertility from 95.1 to 97.3% in broiler breeder flock. Similarly, Narahari (2003) reported that herbal formulations improved fertility in broiler breeders.

Although acceptable fertility levels (90.42 ± 4.10 and 92.18 ± 2.79) were achieved in this study, it is evident that exposing breeder toms to forage will not only improve productivity (Ndelekwute *et al*., 2019) but also fertility. The number of infertile (N1) eggs was significantly ($P < 0.05$) affected by management system and ejaculation frequency. Except for E_1 and E_2, NI increased with increasing ejaculation frequency in both M_1 and M_2. E_4 had the highest ($3.13 + 0.30$ and $2.38 + 0.46$) NI followed by E_3($2.50 + 0.54$ and E_1 2.50 ± 0.71) in both M_1 and M_2 with M_1 having the higher mean values for NI across the four frequencies of ejaculation. NI was significantly lower for E_2 in both M_1 and M_2 respectively. Although the same insemination dose of (0.05ml) was used across the treatments, they did not contain the same number of spermatozoa. This may have accounted for the variations in the NI obtained in this study. Similarly, as ejaculation frequency increased from $E_3 - E_4$, the total number of spermatozoa in the ejaculate appeared to be significantly affected (Thatohatsi, 2009; Ezike *et al*., 2021), reducing the number of spermatozoa at the site of fertilization. The cause of higher NI eggs recorded in this study for E_1 could be due to higher number of aged and morphologically abnormal spermatozoa accumulated over time (Noirault and Brillard, 1999) during the rest period and peroxidation of sperm cell membrane used for insemination. Also, the result obtained for NI in this study for E_3 and E_4 could be due to a decrease in semen quality which is inconsonance with result of Noirault and Brillard (1999), Nwachukwu *et al.* (2006) and Ezike *et al.* (2021), who reported that semen quality traits decline with increasing frequency of ejaculation. Differential physiological conditions of the sperm storage compartment of the hen at the time of insemination, development of immunity against sperm by some breeder hens (Keith, 2008) as well as infertility syndrome – an occasional unexplained infertility in breeder flock (Singh *et al*., 1964) may be implicated for the NI eggs recorded in some treatments of this study. However, NI recorded in this study across the treatments was within the normal range reported by Donoghue (1998) for exotic turkey. This could be attributed to the good quality semen used for insemination as well as young reproductive age of the hens. Percentage fertility (PF) was significantly ($P < 0.05$) affected by ejaculation frequency and management system. Except for E_2 under M_1 and M_2, percentage fertility decreased with increasing ejaculation frequency.PF was generally higher in M_2 than M_1. E_2 had the highest for PF (92.18 ± 2.79 and 90.42 ± 4.10) across the four ejaculation frequencies under M_2 and M_1 respectively, followed by E_1 (80.90 ± 4.58 and $84.39 \pm 4.63\%$) and E_3 (78.22 ± 5.20 and 80.18 ± 4.59). The result of this study could be due to variations in the semen quality characteristics

(Nwachukwu *et al*., 2006). However, the result of this study is within the range (94.51%, 89.89% and 87.5%) reported by Kotlowska *et al.* (2005) for hybrid white Nicholas, Nicholas (N – 700) and Big – 6 strains of turkeys respectively under intensive management system.

The effects of management system and ejaculation frequency on hatchability of fertile local turkey eggs are shown in Table 3. The result of the study indicated significant ($P < 0.05$) effect of management system and ejaculation frequency on the number of early dead embryo (NDE). NDE was highest in hens inseminated with semen collected once per week (E_1) in both M_1 and M_2 followed by E_3 and E_4. NDE did not differ significantly ($P > 0.05$) for E_2 under M_1 and M_2. The reason for the result obtained in this study for E_1, E_3 and E_4 could be attributed to low sperm concentration and greater number of morphologically abnormal spermatozoa in the ejaculate inseminated (Thatohatsi, 2009). Durape(2007) reported an increased in early embryonic mortality in broiler breeders when few sperm were available to fertilize an egg. The result of this study is in line with those of Noirault and Brillard (1999) who reported that aging of spermatozoa causes loss of membrane integrity due to peroxidation as seen in E_1, and higher number immature spermatozoa with head acrosomic droplet for E_4. The result of this study appears to suggest that inseminating hens with semen containing more non-viable and abnormal sperm could lead to poor fertility and eventual embryo death during incubation. This is consistent with the findings of Keith (2008), who reported that even though it takes a single sperm to fertilize an egg, adequate number of morphologically intact sperm is needed to ensure hatchability. This may be due to several factors such as dwindling intra-oviductal sperm motility and oviductal discrepancies which may reduce the number of sperm ascending the infundibulum. Thus, the total number of sperm present in the oviduct is an important factor influencing fertility and early embryonic mortality in poultry (Devegowda, 2009). Eslick and McDaniel (1992) reported that reduced fertility and early embryonic death will increase with decreased number of viable total sperm inseminated. Although embryo death is common in avian species (Thatohatsi, 2009), early embryonic mortality may be as a result of low sperm activity in individual hen (Bramwell, 2002). Although egg hatchability and embryonic mortality can further be affected by such factors as poor egg storage, egg size, age of breeders and incubator shortcomings (Dzoma, 2010), the cause of the NDE recorded in this study in some treatment could be attributed to incubator short coming and unidentified farm cracks because young hens and toms were used in this study, and eggs stored within the recommended range (4 days of lay). The result of this study, however, suggests that the number of early embryonic death could be reduced in artificial insemination programme by inseminating hens with semen collected twice or three times per week. The result of this study showed no significant ($P > 0.05$) effect of management system and ejaculation frequency on the number of late dead embryo (LDE). Late dead embryo was absent in this study. The number of hatched eggs (NHE) was not significantly ($P > 0.05$) affected by management system and ejaculation frequency. Percentage hatchability (PH) recorded in this study was significantly ($P < 0.05$) affected by management system and ejaculation frequency. PH was statistically better in M_2 than M_1 across the four frequencies of ejaculation. However, E_2 had the highest PH in both M_1 and M_2. Percentage hatchability mean values ($85.11 \pm 4.20 – 100.00 \pm 0.00\%$) recorded in this study were within the (95 – 100%) recorded by Keith (2008) for exotic turkeys. The result of the present study indicated that hatchability of fertile eggs was best (100.0 ± 0.00 and $100.00 \pm 0.00\%$) for E_2 under M_1 and M_2 followed by E_3 (97.91 ± 2.09 and $99.16 \pm 0.84\%$) in both M_1 and M_2 groups respectively.

The result of the interaction between management system and ejaculation frequency is shown in Table 4. The present study did not show any significant ($P > 0.05$) interaction effect between management system and ejaculation frequency. This suggests that both management systems could be used to achieve the same fertility and hatchability result in local breeder turkeys.

Conclusion

The result of the present study indicated that management system and ejaculation frequency affected most of the fertility and hatchability parameters measured. Fertility and hatchability were generally better in semi-intensive management. Ejaculation frequency significantly affected most of the fertility and hatchability parameters measured. Twice, per week ejaculation frequency gave the best fertility and hatchability result. It was therefore recommended that local breeder Toms should not be ejaculated more than three times per week in both management systems in artificial insemination programme.

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