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FACTORS AFFECTING FERTILITY AND HATCHABILITY OF EGGS FROM ARTIFICIALLY INSEMINATED CHICKENS

O.A. AMAO[1] AND K.L. AYORINDE
[1]Department of Animal Production and Health, Ladoke Akintola University of Technology, P.M.B 4000, Ogbomoso
Department of Animal Production, University of Ilorin, P.M.B. 1515, Ilorin, Nigeria.

Target Audience: Poultry breeders and researchers

ABSTRACT

An experiment was conducted to investigate the effects of some factors affecting the fertility and hatchability of chicken eggs. In the study, forty-eight 10-month old Yaffa Brown laying hens were employed in a 2 x 2 x 2 factorial experiment. The factors were semen type (whole vs diluted semen) insemination volume (0.05 vs 0.10 ml) and insemination frequency (once vs twice per week).

Semen type had significant effect on fertility and hatchability of chicken eggs. Birds inseminated with whole semen showed significantly ($P < 0.05$) higher fertility than those inseminated with diluted semen. Volume, insemination frequency and their interaction had no significant effects on fertility and hatchability. It was concluded that undiluted semen inseminated twice per week with either 0.05 or 0.10 ml will improve fertility and hatchability of eggs in the chicken.

Key Words: Semen type, insemination dosage, insemination frequency, fertility, hatchability and chicken eggs

DESCRIPTION OF PROBLEM

Poultry Science has over the years been a major source of dietary protein to man throughout the world. While efforts have been intensified towards having possible alternative sources of dietary protein in animal feeds not as much efforts have been geared towards improving the reproductive efficiency of poultry species especially in Nigeria. One approach to improving reproductive efficiency has been through artificial insemination (AI).

While AI has been widely used for ruminants and pigs, only in turkeys has it gained popularity among poultry species (1). Also a daring attempt has been made at the possibility of using AI intensively on guinea fowl (2). In guinea fowl, inseminating a hen twice a week resulted in a 6.4% improvement in egg fertility over once per week. It was established that for diluted semen 0.10 ml dosage was of superior performance over 0.05 ml in fertility (2).

It is essential to appreciate that theoretically only one sperm cell is necessary for fertilization of the ovum, but in practice it is unlikely that only one cell will produce

[1]Corresponding Author

such a result. The high variability in the number of spermatozoa per ejaculate does suggest that opportunity exists for improvement of the fertility and hatchability problems commonly encountered in poultry production. It was against this background that this study was aimed at investigating some of the factors affecting fertility and hatchability of eggs from artificially inseminated chicken to determine a suitable volume and insemination frequency.

MATERIALS AND METHODS

Experimental Animals

Forty-eight 10month old Yaffa Brown laying hens, were involved in a 2 x 2 x 2 factorial design to determine effects of insemination dose, insemination frequency and type of semen on fertility and hatchability. The birds were randomly divided into eight experimental groups of six birds each, kept in pairs in battery cages measuring 0.15 x 0.12 x 0.15 m each.

Fifteen 11-month old cocks of the Harco strain purchased from a commercial poultry farm in Ilorin, Kwara State were also used for the experiment. The birds were treated for possible ectoparasites and then kept in individual cages of same dimensions as above.

All birds were given feed and water *ad libitum* throughout the experimental period. The cocks were trained for eight weeks for response to stimulation to ejaculate.

Preparation of diluent

The diluent, egg-yolk-citrate solution was prepared by adding 100 g freshly laid egg-yolk to 100 ml of 2.9% sodium citrate solution and used immediately.

Semen collection and dilution

Semen was collected daily from the cocks by the double-handed massage method (3, 4 and 5) and pooled. The pooled semen samples were either diluted or used undiluted (whole semen). Dilution was done at 1:1 semen to diluent ratio.

Insemination

Each hen was inseminated between 1200 and 1300 h with 0.05 ml or 0.10 ml of either diluted or whole semen according to the treatment group. The frequency of insemination was either once or twice per week. Days of insemination for the once per week groups were: Monday for 0.10 ml diluted semen; Tuesday for 0.10 ml undiluted semen; Wednesday for 0.05 ml diluted semen and Thursday for 0.05 ml undiluted semen. The insemination days for the twice per week groups were: Monday and Wednesday for 0.10 ml diluted semen; Tuesday and Thursday for 0.10 ml undiluted semen; Wednesday and Friday for 0.05 ml diluted semen and, Thursday and Saturday for 0.05 ml undiluted semen. The insemination exercise was done using a graduated microsyringe.

Semen quality evaluation

Semen quality evaluation was done at the beginning, middle and the end of the experiment. Evaluation was carried out immediately after collection for semen volume, sperm concentration, abnormal spermatozoa and percent motility as

described by Zemjanis (6). Volume was evaluated by directly measuring the semen collected into the graduated microsyringe. Evaluation of motility of sperm cells was done by observing a small drop of undiluted semen on a pre-warmed slide under a light microscope at 100 magnification. In sperm concentration 1-part semen was diluted with 10 parts diluent (egg-yolk-citrate solution) and examined using a digital photometer calibrated against haemocytometer counts. The percentage live/dead sperm was evaluated using the eosin nigrosin supra vital-staining method.

Egg collection and incubation

Egg collection started 72 hours after the first insemination and proceeded for two weeks. Eggs collected were appropriately labelled and set daily for incubation over a period of three weeks using a laboratory incubator (500 eggs capacity). Incubator temperature and humidity were maintained at 37.7°C and 55 60% respectively.

Candling was done on the 7th day of incubation to test for fertility and on the 18th day for dead germs. Unhatched eggs were cracked open after 21 days of incubation and number of embryos that died in shell was recorded.

Statistical analysis

Data collected for fertility and hatchability were subjected to statistical analysis appropriate for a factorial design. Where treatment effect was significant the treatment means were subjected to Duncan's Multiple Range test (7).

RESULTS AND DISCUSSION

The results of this study are presented in Tables 1 and 2. Table 1 shows the maximum, minimum and mean values for semen characteristics. Mean values were 0.12 ml, 3.44 x $10^9 ml^{-1}$, 72.5 % and 9.54 % for semen volume, sperm concentration, percent sperm motility and abnormal sperm cells respectively. Table 2 shows the effects of semen type, volume and insemination frequency on fertility and hatchability. Groups of birds inseminated with whole semen showed significantly ($P< 0.05$) higher fertility than those inseminated with diluted semen. The highest fertility was obtained from the group of birds inseminated with 0.10 ml whole semen twice per week.

Table 1: Maximum, minimum and mean values for semen volume, concentration and motility

Semen characteristics	Maximum	Minimum	Mean ± sem
Volume (ml)	0.18	0.08	0.12+0.02
Sperm concentration ($x10^9$/ml)	4.35	2.15	3.44+0.34
Percent sperm motility (%)	78	66	72.5+1.28
Abnormal sperm cell %	12.50	7.20	9.54+0.69

The percentage of fertility obtained in this work irrespective of semen volume and frequency of insemination was much higher than those earlier reported in naturally mated stock (8). The groups of birds inseminated with whole semen

Table 2. Effect of semen type, volume and insemination frequency on fertility and hatchability of eggs

Semen characteristics	Diluted Semen				Whole Semen			
Volume (ml)	0.05		0.10		0.05		0.10	
Frequency (wk-1)	Once	Twice	Once	Twice	Once	Twice	Once	Twice
Fertility (%)	40.68[a]	46.15[a]	54.35[a]	59.46[a]	80.45[bc]	85.71[bc]	77.19[b]	88.50[c]
Hatchability of fertile eggs (%)	29.17[a]	16.67[b]	52.00[a]	18.18[b]	35.14[a]	42.86[a]	40.91[a]	37.50[a]
Hatchability of all Eggs (%)	11.86[b]	7.69[b]	28.26[a]	10.81[b]	28.26[a]	36.73[a]	31.58[a]	33.33[a]

[ab]: Values superscripted differently under the same charactersitics differ significantly (P<0.05)

showed a significantly ($P < 0.05$) higher fertility than those inseminated with diluted semen. Probably there was an inadequate storage of spermatozoa in the infundibulum of the diluted semen inseminated birds. This could result in rapid depletion of spermatozoa from the reproductive tract and urino-genital junction storage site. This implies that some ova stood the chance of not being fertilized.

Increasing the frequency from once to twice per week resulted in an increase in fertility by 5.5 % using 0.05 ml diluted semen and 5.1 % using 0.10 ml diluted semen. Using 0.05 ml whole semen and increasing the frequency to twice per week resulted in a 5.26% improvement in fertility. When 0.10 ml was inseminated twice per week there was an improvement of 11.7% over the performance of those inseminated with 0.10ml once per week.

The high egg fertility obtained with whole semen indicates that enough sperm cells were found in the hens' reproductive tracts and were able to support higher fertility than what was obtained with diluted semen. This disagrees with the report of Ayorinde (2) that diluted semen gave higher fertility in guinea fowls. It however agrees with the report of Geisson and Sexton (1) that dilution resulted in a decline in fertility of birds irrespective of the frequency of insemination. The best performance in this study was most evident at 0.10 ml semen inseminated twice per week. This could be attributed to continuous presence of sufficient number of viable sperm cells in the vaginal fossulae of the female to fertilise the eggs. This observation supports that of Ayorinde (2) who stressed the superiority of 0.10 ml over 0.05 ml.

Within each dose, although there were differences in fertility, the differences were not significant. Analysis of variance showed that only semen type had significant ($P < 0.05$) effect on fertility. Semen volume frequency and their interaction effects were not significant.

While the effect of semen type on fertility was significant, effects of semen volume, frequency of insemination and all interactions were not. This partially disagrees with other findings Geisson and Sexton (1) and McCartney (9) in which a significant ($P < 0.05$) effect of semen volume on fertility and hatchability was shown.

Inspite of the high fertility obtained, hatchability was generally low. The whole semen inseminated groups of birds showed better hatchability than the diluted semen inseminated birds (Table 2). Doubling the volume of insemination once per week for diluted semen resulted in a sharp increase in hatchability (from 29.17 to 52.0 %). However, inseminating both 0.05 and 0.10 ml twice per week resulted in a decline in hatchability. Increasing the frequency of insemination of whole semen from once to twice per week using 0.05 ml, resulted in 7.7% increase in hatchability. The reverse was the case when 0.10 ml whole semen was inseminated twice per week. On the overall, only one factor (semen type) had a significant ($P < 0.05$) effect on hatchability.

Despite the high fertility, the hatchability obtained in this study was very low. It could probably be that the incubator conditions (humidity and temperature) were not adequate to support appreciable hatchability. However, hatchability showed the same trend as observed in fertility. The whole semen - inseminated birds performed better than the diluted semen inseminated birds. Furthermore, with

diluted semen, insemination done twice weekly using either 0.05 ml or 0.10 ml resulted in a decline in hatchability. This means that for diluted semen better hatchability could be achieved by inseminating the birds once per week. Probably this could be attributed to the fact that harvesting the sperm cells from cocks too often may not allow the successive sperm cells to mature enough for hatchability. When immature spermatozoa are used for insemination they may struggle to fertilize the ova but may not be virile enough for hatching.

CONCLUSIONS AND APPLICATIONS

It could be concluded that whole semen inseminated twice per week in either 0.05 or 0.10 ml will give better performance in artificial insemination of chickens.

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