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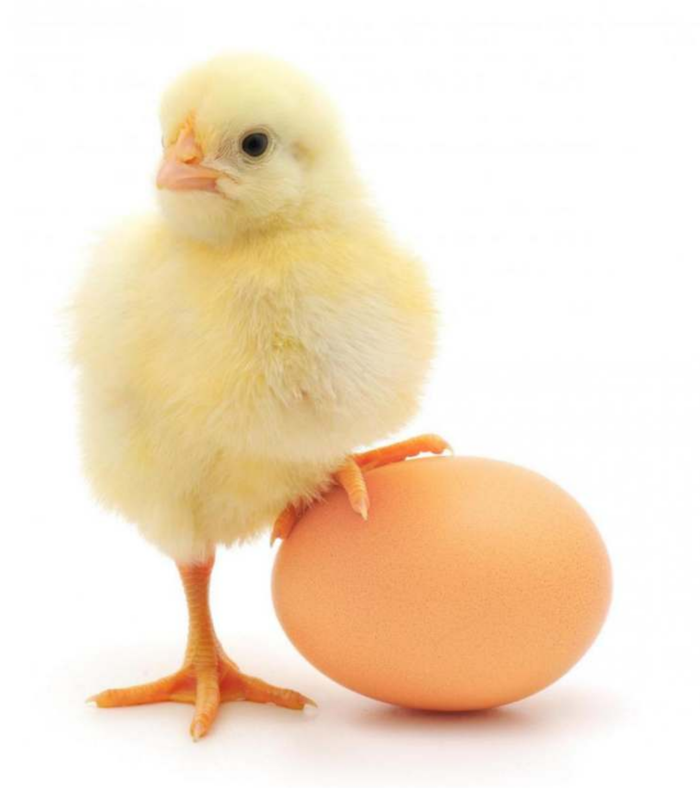

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308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorijps@gmail.com

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Osborne Selection Index and Semen Traits Interrelationships In Rhode Island Red and White Breeder Cocks

M. Kabir[1], O.O. Oni[2] and G.N. Akpa[1]
[1]Department of Animal Science, Ahmadu Bello University, Zaria, Nigeria
[2]National Animal Production Research Institute, Shika-Zaria, Nigeria

Abstract: Three hundred and sixty-one cocks from five hatches, one week apart, were used in this study. The birds which were made up of 203 birds from strain A (male line) and 158 birds from strain B (female line) were subjected to semen collection using the massage technique. The ejaculates were then subjected to both physical and chemical evaluations for semen quality analysis. The parameters considered were semen volume, semen colour, sperm progressive motility, sperm concentration, total sperm per ejaculate, concentration of live sperm and percent abnormal sperm. Results showed that the mean values for all the parameters lie within the acceptable range reported for normal cock semen. Moderate to high heritability estimates for most of the semen traits were also observed. The least square means (±SE) for semen volume, sperm progressive motility, sperm concentration, total sperm per ejaculate and concentration of live sperm cells obtained in this study were 0.42±0.02 ml, 73.46±2.04%, $1.47\pm0.15\times10^9$/ml, $64.15\pm5.67\times10^9$/ml and 86.45±2.63%. The heritability estimates obtained were 0.55±0.03 for semen colour, 0.45±0.08 for semen volume, 0.83±0.04 for sperm progressive motility, 0.52±0.06 for sperm concentration, 0.33±0.02 for total sperm count, 0.46±0.03 for concentration of live sperm cells respectively. High and positive genetic correlations between Osborne Selection Index and semen volume, semen colour, sperm concentration as well as with concentration of live spermatozoa were also obtained. The lowest value (0.008±0.010) of phenotypic correlation obtained was for total sperm per ejaculate and the highest value (0.066±0.027) was for semen volume. Therefore the genetic correlation between Osborne Selection Index and most semen traits were positive, hence, selection of males on the index values, currently been practiced in NAPRI, will not bring about any deterioration in semen quality. On the other hand, due to significantly negative genetic correlation between Osborne index and abnormal sperms, it will indirectly improve the semen quality of both lines which in turn may yield better fertility in the Rhode Island flock.

Key words: Osborne index, Rhode Island chicken, semen characteristics, selection

Introduction

Some important economic traits in livestock production are limited to only one sex and, therefore, are called sex-limited traits. For instance, cocks do not lay eggs neither do bulls produce milk. However these males do possess and transmit genes for these traits to their offspring. Therefore, the prediction of the breeding value of the male is obtained from the means of his full-and half-sisters (Liljedhal *et al*., 1979). Osborne index is a technique for multiple objective selection which entails separate determination of the value for each trait selected for according to its relative economic importance, its heritability, genetic and phenotypic correlations between the different traits. The values obtained are then added up together to give a total score (index). Individuals with the highest score are then selected and kept for breeding purposes (Osborne, 1957).

The Osborne Index selection has been a very effective method for improving egg production in chicken (Johari *et al*., 1991). Reports regarding interrelationship between Osborn index and semen production traits are lacking in literature. Sternova *et al*. (1984) reported a non significant phenotypic correlation between semen volume and egg production of full-sisters. While significantly positive correlation between these traits was reported by Thiyagasundaram *et al*. (1985). Similarly, Johari *et al*. (1991) reported low to medium genetic correlation between Osborne index and semen appearance, semen motility, semen volume and total sperm per ejaculate.

The estimates of heritability obtained in this study were similar to values reported by Soller *et al*. (1965) for semen volume (0.41), sperm progressive motility (0.87) and sperm concentration (0.50) respectively, which they regarded as sufficiently high as to warrant mass selection for semen quality in improving these traits.

This paper therefore attempts to study the relationship between Osborne Selection Index values and semen traits in two strains of Rhode Island chickens selected for part-year egg production.

Materials and Methods

The experiment which last for 12 months (October 2003 to September 2004), was conducted at the poultry breeding unit of the National Animal Production

Research Institute (NAPRI), Shika-Zaria. Shika is geographically situated between latitude 11° 12’ N and longitude 7°33’ E at an altitude of 640 M above sea level (Akpa *et al*., 2002). It is located 22 km northwest of Zaria City and is vegetationally in the northern guinea savannah zone of Nigeria. Detailed description of the experimental site was given by Kabir *et al*. (2006).

The stock consisted of 361 birds made up of 166 males and 195 females. They were brooded and reared in deep-litter floor pens. Floor space allowed per bird varied from 0.15 to 0.50m^2 depending on age of bird. From 0-8 weeks old, chicks were fed chick mash containing 20% CP and 2722 Kcal ME/Kg, then from 8-18 weeks grower ration containing 16% CP and 2737 Kcal ME/Kg was fed, while from 18 weeks onward breeder mash was given. All rations were formulated and mixed at the feed mill of the Institute. Throughout the experimental period, feed and clean drinking water were provided to all birds *ad libitum*. At 18 weeks, they were randomly placed in individual cages and monitored for semen production. Prior to the experiment, the cocks were given two weeks preliminary training so as to ejaculate and emit semen by the massage technique described by Lake and Stewart (1978).

The procedure for evaluation of semen quality traits has been detailed by Singh *et al*. (1987). The following traits were recorded: semen colour, semen volume (ml), sperm progressive motility (%), sperm concentration ($x10^9$/ml), total sperm per ejaculate ($x10^9$/ml), concentration of live spermatozoa ($x10^9$/ml) and percent abnormal sperm (%). For colour determination, a score of 3, 2 or 1 was used for creamy, milky or colourless respectively.

The genetic parameters were estimated using the hatch adjusted data from a model whereby the variance component was partitioned into those due to Sire, Dam or Environment. The model fitted was of the Nested design (Henderson, 1963), in which a sire was mated to several dams with each mating producing several offspring.

The statistical model used is as follows:

$$Y_{ijk} = \mu + s_i + d_{ij} + e_{ijk}$$

Where Y_{ijk} is the record of the k^{th} progeny of the j^{th} dam mated to i^{th} sire, μ is the common mean, s_i is the effect of i^{th} sire, d_{ij} is the effect of the j^{th} dam mated to i^{th} sire, e_{ijk} is the uncontrollable environmental and genetic deviations attributable to the individual (all error terms were assumed to be random, normal and independent with expectation equal to zero).

For heritability estimation, the data were used to calculate the sire component of variance derived from the above model using SAS programme (1996). The formula used is as follows;

$$h^2 = \frac{4\sigma^2_S}{\sigma^2_S + \sigma^2 E}$$

Where;

h^2 = Heritability based on sire variance component, σ^2_S

= Sire variance component,

σ^2_E = Error variance component. The standard error of heritability was calculated using sampling variance of intraclass correlation (Falconer, 1989).

The Osborne Selection Index used in this study was calculated as follows according to the method of Hazel (1943); Osborne (1957) and Henderson (1963).

$$I_0 = W_1 (F_D\text{-}P) + W_2 (F_S\text{-}P)$$

Where W_1 and W_2 are weighting factors for dam and sire family averages based on number of progeny of part year egg production, F_D and F_S are the dam and sire family means and P is the population mean.

Results and Discussion

Mean performance and heritability estimates: The least square means and heritability estimates for semen traits obtained in this study were presented in Table 1. The mean values for semen volume obtained in this study were lower than 0.7-0.8 ml reported by Bajpai (1963), 0.58-0.80 ml reported by Nwagu *et al*. (1996) and 0.48-0.75 ml reported by Lee *et al*. (1999). They were however higher than the mean values of 0.17-0.37 ml reported by Saeid and Al-Soudi (1975), 0.28 ml reported by Bah *et al*. (2001), 0.39 ml reported by Ezekwe *et al*. (2003) and 0.24-0.27 ml reported by Ezekwe and Machebe (2004). Differences in the volume of semen observed can be attributed to breed, age and environmental factors (Ezekwe and Machebe, 2004). The colour of semen observed in this study was milky and agree with the observed colour reported by Nwagu *et al*. (1996), who worked on similar breed of Rhode Island breeder cocks. The mean sperm progressive motility, sperm concentration as well as total sperm per ejaculate observed in this study were in agreement with the values reported by Bajpai (1963), Saeid and Al-Soudi (1975), Nwagu *et al*. (1996), Lee *et al*. (1999) and Ezekwe and Machebe (2004). Generally, the mean performance of birds used in this study with respect to semen characteristics was within the range reported in literature.

The estimates of heritability obtained in this study for most semen traits were in agreement with the reported values in literature (Ebangi and Ibe, 1994; Egbunike and Nkanga, 1999). The values were found to be similar to those reported by Soller *et al*. (1965) for semen volume (0.41), sperm progressive motility (0.87) and sperm

Table 1: Least Square Means (±SE) and Heritability estimates (±SE) for semen traits in two strains of Rhode Island breeder cocks (n = 329)

Parameters	X±SE	Range	h^2±SE
Semen colour	2.96±0.11	1.0-3.0	0.55±0.03
Semen volume (ml)	0.42±0.02	0.05-0.75	0.45±0.08
Sperm progressive motility (%)	73.46±2.04	0-100	0.83±0.04
Sperm concentration ($x10^9$/ml)	1.47±0.15	0.03-5.34	0.52±0.06
Total sperm per ejaculate ($x10^9$/ml)	64.15±5.67	25-100	0.33±0.02
Concentration of live spermatozoa (%)	86.45±2.63	0-100	0.46±0.03
Percent abnormal sperm (%)	11.07±0.18	1.33-60.33	0.42±0.03

Table 2: Genotypic and phenotypic correlations between Osborne Selection index and semen quality traits in two strains of Rhode Island breeder cocks

Traits	Genotypic correlation		Phenotypic correlation	
Association of	r_g(S)	r_g(D)	r_g(S+D)	r_p
Semen colour	0.538±0.114	0.639±0.130	0.415±0.103	0.031±0.031
Semen volume (ml)	0.386±0.142	0.541±0.177	0.567±0.139	0.066±0.027
Sperm progressive motility (%)	0.361±0.201	0.217±0.24	0.425±0.174	0.042±0.029
Sperm concentration ($x10^9$/ml)	0.491±0.138	0.564±0.151**	0.352±0.061**	0.038±0.033
Total sperm per ejaculate ($x10^9$/ml)	0.229±0.067	0.367±0.014	0.235±0.048	0.008±0.010
Concentration of live spermatozoa (%)	0.461±0.137	0.442±0.086**	0.311±0.100	0.024±0.031
Percent abnormal sperm (%)	-0.361±0.148**	-0.337±0.101	-0.312±0.030**	-0.012±0.005

**Significant at $p<0.01$

concentration (0.50) respectively, which they regarded as sufficiently high. When the heritability of a trait is high, the correlation between phenotype and the genotype of the individuals on the average should also be high and selection on the basis of individual's own phenotype should be effective. Low heritability estimate on the other hand, is an indication of low correlation between the genotype and phenotype. Hence, low heritability estimate means that variations due to additive gene action are probably small. Rather non-additive gene action such as over dominance, dominance and epistasis may be important. In general, differences in heritability estimates could be attributed to method of estimation, breed, environmental effects and sampling error due to small data or sample size. Environmental (high temperature and humidity) and poor management conditions are known to increase the residual variance and decrease the heritability estimates (Soller *et al.*, 1965).

The genotypic and phenotypic correlations between Osborne selection index and semen quality traits are presented in Table 2. The genetic correlations between Osborne selection index and semen colour, semen volume, sperm progressive motility, sperm concentration and concentration of live spermatozoa observed in this study were moderate to high in magnitude. The values were in fact higher than those reported by Johari *et al.* (1991) for semen volume (0.160), semen colour (0.120), sperm progressive motility (0.210) and sperm concentration (0.035). The observed values also agree with reports from other authorities; Ansah *et al.* (1980); Brah *et al.* (1991). The dam component genetic correlation between Osborne selection index and semen colour, semen volume and sperm concentration were positive and high in magnitude than the sire component. This shows the importance of maternal effect for these associations.

Osborne selection index was observed to be negatively correlated with percent abnormal sperm genetically as well as phenotypically (Table 2). This negative association was in the desirable direction, because the continuous use of the Osborne index to select males for breeding purposes on the basis of their collateral sibs will indirectly improve the semen quality of both lines, which may in turn yield better fertility in the Rhode Island flock.

Conclusion: The birds used in this study are efficient in optimum sperm cell production with acceptable sperm picture. The higher estimate of heritability obtained for most of the semen traits is suggestive of the fact that additive gene action is playing a major role in the inheritance of these traits and hence the mating of the best to best should produce more desirable offspring. Osborne selection index which has been used (and is still being used) for the selection of cocks based on the performance of their sibs in National Animal Production Research Institute (NAPRI), Shika-Zaria, where this research was conducted, showed positive and high correlation with most semen traits. This is an indication that the index has no negative effect on semen quality traits. In addition, selection of these birds based on the index for semen traits will certainly improve semen output and yield better fertility in the flock.

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