VOL. 4, NO. 4, JULY 2009 ISSN 1990-6145
ARPN Journal of Agricultural and Biological Science

www.arpnjournals.com

GENETIC EVALUATION OF ROOSTERS FOR FERTILITY AND HATCHABILITY ACCORDING TO SEMEN INDEX AND INDIVIDUAL SEMEN TRAITS

Firas R. Al-Samarai[1], Thamer K. Al-Ganabi[2], Ahmed M. Al-Nedawi[3], Kalid A. Al-Soudi[3]
[1]Department of Veterinary Public Health, College of Veterinary Medicine, University of Baghdad, Baghdad, Iraq
[2]Department of Biology science, College of Science, University of Karbala, Karbala, Iraq
[3]Department of Animal Resource, College of Agriculture, University of Baghdad, Baghdad, Iraq
E-Mail: firas_rashad@yahoo.com

ABSTRACT

A study was conducted to evaluate the 24 roosters according to semen index (SI) which included several semen traits and because this method is time consuming and technically difficult, other methods for evaluation of roosters depend on individual semen traits, were applied as practical methods. Spearman's coefficients of rank correlations were estimated between BLUP of semen index and BLUP of several semen traits to investigate the possibility of using one semen trait instead of semen index in evaluation of roosters. BLUP values of mass motility had the highest coefficient of rank correlation (0.71) with the BLUP values of SI. The results of this study could consider good evidence of using mass motility for evaluated roosters for fertility and hatchability.

Keywords: genetic evaluation, leghorn, fertility, hatchability.

INTRODUCTION

Reproductive performance is critical to efficient production in poultry and suitable selection criteria for males based on semen characteristics have been submitted in roosters (McDaniel *et al*., 1998).

To avoid losses in fertility, proper evaluation of semen prior to AI or storage is very important (Hammerstedt, 1992). Because of semen evaluation is extremely important for semen storage and AI; a method of semen evaluation which is rapid, economical, objective and strongly predictive of fertility would be beneficial to the poultry industry (Dumpala *et al*., 2006).

The main objective of evaluating semen quality should be to predict the fertility of an individual male (Hammerstedt, 1996).

Genetic evaluation of semen quality for roosters will improve the fertility and hatchability in stocks (Parker and McDaniel, 2002). According to Donoghue (1999), semen evaluation tests can be a valuable tool in the management of roosters or toms.

Traditional methods were used to determine fresh semen quality include parameters such as semen volume, color, concentration, and sperm motility, viability, and morphology (Donoghue and Wishart, 2000) as well as metabolic activity (Chaudhuri *et al.*, 1988; Wishart, 1989). All of these methods of semen evaluation are based on a single sperm quality parameter and do not consider all semen quality characteristics. Hence, method of semen evaluation that does include several measures of semen quality in a single index number is the sperm quality index (SQI), which is a single number that provides an estimate of overall semen quality of roosters (McDaniel *et al.*, 1998; Parker *et al*., 2000) and toms (Neuman *et al*., 2002). As a result of previous mammalian and avian researches using this method, it was reasoned that this method of semen evaluation could be used to select roosters within the poultry industry for improved reproductive performance (McDaniel *et al*., 1998; Parker *et al*., 2000; Neuman *et al*., 2002; Dumpala, 2006).

Due to the limiting resources in Iraq it is not possible to conduct such test, because the sperm quality analyzer (SQA) was not available, therefore, this research was undertaken to evaluate roosters according to another semen index which included several semen traits, each trait was scored by number according to its importance and the sum of all numbers for each rooster represent its value. This assay however is time consuming and technically difficult but may be a suitable substitute of SQI particularly in some countries such as Iraq, because it could used without any need to SQA.

In order to use more practical method for evaluation of fertility depend on one trait only, BLUP of roosters were estimated according to each individual trait of semen index, then Spearman's coefficients of rank correlations were estimated between BLUP of semen index and BLUP of each of individual semen traits to investigate the possibility of using one semen trait in stead of semen index in evaluation of roosters.

MATERIALS AND METHODS

The experiment was conducted at the College of Agriculture / University of Baghdad. 24 Roosters and 144 Hens of Wight Leghorn aged 20 weeks were used as essential flock, divided into 24 families (one male and six females to each family). They were bred in individual cages (40 x 40 x 45 cm), feed and water were used *ad lipitum*, semen was calculated according to Burrows and Quinn method (1937), whereas the individual and mass motility was estimated according to Parker *et. al.* (1942), died and abnormal sperms were scored according to Lake and Stewart (1978) .

All semen characteristics were estimated at 24, 28 and 32 weeks of age of offspring (193 roosters). Semen index (SI) was estimated as following:

Mass motility ≤ 69 % = 1, mass motility 70 – 75% = 2, mass motility ≥ 75% = 3. Individual motility ≤ 75 % = 1, individual motility 76-79 % = 2, individual motility ≥ 79 % = 3. Dead spermatozoa ≤ 10 % = 3, dead spermatozoa 11 – 12 % = 2, dead spermatozoa ≥ 12 % = 1. Abnormal spermatozoa ≤ 9 % = 3, abnormal spermatozoa 10 - 12 % = 2, abnormal spermatozoa ≥ 12 = 1. Ejaculate volume ≤ 0.20 = 1; ejaculate volume 0.21 – 0.30 = 2, ejaculate volume ≥ 0.30 = 3.
SI = (Mass motility + Individual motility + Dead spermatozoa + Abnormal spermatozoa + Ejaculate volume).

Statistical analysis

GLM within SAS program (2001) was used to investigate the effect of fixed factors (Hatch No. , Age and SI) on fertility and hatchability as the following model:

$$Y_{ijk} = \mu + A_i + H_j + b\,(u_i - \bar{u}) + e_{ijk}$$

Where Yijk is any trait considered in this study, μ is the overall mean, Ai is the age effect, Hj is the hatch No. effect, b (ui - ū) is the regression of two traits on SI and eijk is the residual effect.

Mixed model was used to estimate variance components for SI by using Minimum Variance Quadratic Unbiased Estimation (MIVQUE) (Rao, 1971) as following model:

$$Y_{ijkl} = \mu + A_i + H_j + S_K + e_{ijkl}$$

Where Sk the effect of sire (24 roosters) and other effects are the same in first model. Heritabilities were calculated as follows:

$$h^2s = 4\,\sigma^2s / (\sigma^2s + \sigma^2e)$$

Where h^2s = heritability; σ^2s = variance of sires; σ^2e = variance of error.

Best Linear Unbiased Prediction (PLUP) values of SI and other traits were estimated by using Harvey program (1990).

Spearman's coefficients of rank correlations were estimated between BLUP of semen index and BLUP of several semen traits using SAS program (2001).

RESULTS AND DISCUSSIONS

The overall means of fertility and hatchability were 77.24 and 78.82% respectively. These results were in agreed with result obtained by Al-Daraji, (2001) but lowered than estimates of other researchers (Melean *et al.,* 1998; Islam *et al.,* 2002) this may be due to differences in breed and environment.

SI considered as regression in the employed model to investigate its effect on fertility and hatchability as a first step. Results revealed that fertility and hatchability were affected significantly ($P < 0.01$) by SI (Table-1 and 2). The coefficients of regression of two traits on SI were 1.68 and 1.17% respectively (Table-3 and 4). Age have a significant effect on fertility whereas the effect was not significant on hatchability. Neither fertility nor hatchability affected significantly by hatch no.

According to these results, step two was submitted when roosters were evaluated by estimating BLUP depending on the SI (Table-5).

The BLUP value of SI for the best rooster was 2.66 whereas the lowest was-3.89.

In regard to this method Donoghue (1999) stated that semen quality tests currently available to the poultry industry are time-consuming, labor intensive and unreliable predictors of fertility and semen quality. Hence another evaluations of roosters were taken out depend on one trait of all traits included in SI.

In order to choosing the best single trait that could be used in evaluation of roosters, Spearman's coefficients of rank correlations were estimated between BLUP of semen index and BLUP of each traits included in SI. The correlations between SI and each of mass motility, individual motility, dead spermatozoa, abnormal spermatozoa and ejaculate volume were 0.71, 0.69, 0.55, 0.52 and 0.65 respectively and all estimates were significant ($P < 0.01$) (Table-6).

These findings demonstrate that using the mass motility for evaluation of roosters could be beneficial method due to the highest Spearman's coefficients of rank correlation between SI and mass motility. On the other hand, heritabilities of SI and all semen traits were presented in Table-7. It's obvious that the heritability of SI had the lowest estimate (0.15), whereas the highest was mass motility (0.29). That's mean the selection of roosters according mass motility is more beneficial compare to other traits.

In order to certify the importance of mass motility on fertility and hatchability, mass motility considered as regression in the employed model to investigate its effect on these traits.

Results revealed that the two traits affected significantly ($P < 0.01$) by mass motility (Table-8 and 9). The coefficients of regression of fertility and hatchability on mass motility were 0.99 and 0.67%, respectively.

Due to this study considered as traditional method, it's very imperative to conduct a new method in Iraq by using SQI in evaluation of roosters to get more gain in fertility and hatchability.

ACKNOWLEDGEMENTS

The authors would like to thank Dr. Ahmed A. Al-Delemi for his assistance with the various aspects of the study.

REFERENCES

A.M. Donoghue. 1999. Prospective approaches to avoid flock fertility: Predictive assessment of sperm function traits in poultry. Poultry Science. 78: 437-443.

A.M. Donoghue and G.J. Wishart. 2000. Storage of poultry semen. Animal Reproduction Science. 62: 213-32.

C.D. McDaniel, J.L. Hannah, H.M. Parker, T.W. Smith, C.D. Schultz, and C.D. Zumwalt. 1998. Use of a sperm analyzer for evaluating broiler breeder males. 1. Effects of

ARPN Journal of Agricultural and Biological Science

altering sperm quality and quantity on the sperm motility index. Poultry Science. 77: 888-893.

C.R. Rao. 1971. Minimum variance quadratic unbiased estimation of variance component. Journal of Multivariate Analysis. 1: 445-456.

D.G. Chaudhuri, G.J. Wishart, P.E. Lake and O. Ravie. 1988. Predicting the fertilizing ability of avian semen: a comparison of a simple colorimetric test with other methods for predicting the fertilizing ability of fowl semen. British Poultry Science. 29: 847-51.

D.J. Melean, A.J. Frltmann and D.P. Froman. 1998. Transfer of sperm into a chemically defined environment by centrifugation through 12% (wt/vo) accudenz. Poultry Science. 77: 163-168.

G.J. Wishart. 1989. Physiological changes in fowl and turkey spermatozoa during in vitro storage. British Poultry Science. 30: 443-54.

H.J. Al-Daraji. 2001. Sperm-egg penetration in laying breeder flocks: a technique for the prediction of fertility. British Poultry Science. 42: 266-270.

H.M. Parker, J.B. Yeatman, C.D. Schultz, C.D. Zumwalt and C.D. McDaniel. 2000. Use of a sperm analyzer for evaluating broiler breeder males. 2. Selection of young broiler breeder roosters for the sperm quality index increases fertile egg production. Poultry Science. 79: 771-777.

J.E. Parker, F.F. Mckenzine and H.L.Kempster. 1942. Fertility in the male domestic fowl. Missouri. Agriculture Express Research Bulletin No. 374.

M.S. Islam, M.A.R. Howlider, F. Kabir and J. Alam. 2002. Comparative assessment of fertility and hatchability of Barred Plymouth Rock, White Leghorn, Rhode Island Red and White Rock hen. International Journal of Poultry Science. 1: 85-90.

P.E. Lake and J.M. Stewart. 1978. Artificial Insemination in Poultry. Ministry of Agriculture, Fisheries and food bulletin No. 213. Her Majesty's Stationery Office, London.

W.H. Burrows and J.P. Quinn. 1937. The collection of spermatozoa from the domestic fowl and turkey. Poultry Science. 16: 19-24.

P.R. Dumpala, H.M. Parker and C.D. McDaniel. 2006. Similarities and differences between the sperm quality index and sperm mobility index of Broiler Breeder semen. Poultry Science. 85: 2231-2240.

R.H. Hammerstedt. 1992. Artificial insemination using extended liquid semen: An old technology of great value to modern industry. In: Proceedings of 41st National Breeders Roundtable. Poultry Breeders of America, St. Louis, MO. pp. 163-186.

R.H. Hammerstedt. 1996. Evaluation of sperm quality: Identification of the sub fertile male and courses of action. Animal Reproduction Science. 42: 77-87.

SAS Institute. 2001. The SAS System for Windows, Release 6.12. SAS Inst. Inc., Cary, NC.

S.L. Neuman, C.D. McDaniel, L. Frank, J. Radu, M.E. Einstein and P.Y. Hester. 2002. Utilization of a sperm quality analyzer to evaluate sperm quantity and quality of turkey breeders. British Poultry Science. 43: 457-464.

W.R. Harvey. 1990. Mixed models least-square and maximum likelihood computer program. Users Guide for LSMLMW The Ohio University Columbus, Ohio.

ARPN Journal of Agricultural and Biological Science

Table-1. Analysis of variance for the effect of some fixed factors on fertility.

S.O.V	DF	Mean Square	F Value	Pr > F
Age	2	57.21	1.79	0.1684
HN	2	77.19	2.41	0.0609
SI	1	6770.19	211.47	0.0001
Error	573	32.01		

HN= Hatch number

Table-2. Analysis of variance of the effect of some fixed factors on hatchability.

S.O.V	DF	Mean Square	F Value	Pr > F
Age	2	132.20	4.07	0.0175
HN	2	67.09	2.07	0.12
SI	1	13694.39	422.09	0.0001
Error	573	32.44		

Table-3. Least square means ± S.E. for the effect of age (weeks) and hatch no. and SI on fertility and hatchability.

Trait	No. obs.	LSM ± S.E (Fertility)	LSM ± S.E (Hatchability)
Overall means	579	77.24 ± 0.17	78.82 ± 0.18
Age (weeks)			
24	193	77.90 ± 0.43 a	79.39 ± 0.43 a
28	193	76.27 ± 0.41 b	78.56 ± 0.41 a
32	193	77.44 ± 0.43 a	78.48 ± 0.42 a
No. of hatch			
1	264	77.51 ± 0.35 a	78.98 ± 0.34 a
2	168	76.49 ± 0.44 a	78.05 ± 0.43 a
3	147	77.61 ± 0.66 a	79.39 ± 0.46 a
SI	579	1.68 ± 0.07**	1.17 ± 0.07**

Means in the same column with no common superscripts differ significantly (P < 0.01)

Table-4. Least square means ± S.E. for the effect of age (weeks) and hatch no. on SI.

Trait	No. obs.	Least square means ± S.E
Overall means	579	10.22 ± 0.28
Age (weeks)		
24	193	8.47 ± 0.20 c
28	193	10.44 ± 0.20 b
32	193	11.69 ± 0.20 a
No. of hatch		
1	264	10.33 ± 0.17 a
2	168	9.94 ± 0.21 a
3	147	10.34 ± 0.23 a

Means in the same column with no common superscripts differ significantly (P < 0.01)

ARPN Journal of Agricultural and Biological Science

Table-5. The rank of BLUP values for 24 roosters Depend on SI.

Rank of roosters	Rooster No.	BLUP values
1	18	-3.89
2	10	-2.58
3	17	-2.51
4	15	-1.85
5	5	-1.73
6	2	-1.50
7	23	-1.41
8	13	-0.71
9	4	-0.45
10	12	-0.37
11	1	-0.25
12	19	0.00
13	22	0.15
14	7	0.59
15	9	0.81
16	24	0.89
17	3	1.09

Table-6. Spearman's coefficients of rank correlation between BLUP of SI and BLUP of other traits.

Trait	SI
Mass motility	0.71 **
Individual motility	0.69 **
Dead spermatozoa	0.55 **
Abnormal spermatozoa	0.52 **
Ejaculate volume	0.65 **

** ($P < 0.01$)

Table-7. Heritabilities of SI and other traits included in the SI.

Trait	**Heritability** (h^2)
Semen index	0.15
Mass motility	0.29
Individual motility	0.28
Dead spermatozoa	0.22
Abnormal spermatozoa	0.24
Ejaculate volume	0.26

ARPN Journal of Agricultural and Biological Science

Table-8. Analysis of variance for the effect of some fixed factors on fertility.

S.O.V	DF	Mean Square	F Value	Pr > F
Age	2	269.23	8.68	0.0002
HN	2	49.40	1.59	0.2042
MM	1	14515.40	468,06	0.0001
Error	573	31.01		

MM = Mass motility

Table-9. Analysis of variance for the effect of some fixed factors on hatchability.

S.O.V	DF	Mean Square	F Value	Pr > F
Age	2	105.77	3.28	0.0382
HN	2	68.23	2.12	0.1211
MM	1	6660.91	206.83	0.0001
Error	573			