Semen Characteristics of Local Breeder Cocks in the Sahel Region of Nigeria

G.S. Bah[1] S.U.R. Chaudhari[2] J.D. Al-Amin[2]

Key words

Chicken - Cock - Semen - Seasonal variation - Sahel - Nigeria.

Summary

Semen characteristics of local cocks (60.9 ± 10.6 weeks old) in the Sahel region of Nigeria were recorded from May to September 1998. Mean values (± SD) were: semen volume 0.28 ± 0.14 ml, sperm concentration 2.26 ± 1.08 x 10^9 sperm/ml, total sperm count 0.64 ± 0.44 x 10^9 sperm/ejaculate, percentage of live spermatozoa 86.6 ± 8.4%, individual motility 73.9 ± 0.2%, pH 7.4 ± 0.2, and abnormal spermatozoa 11.6 ± 8.5%. Sperm concentration, total sperm count and semen volume were positively correlated (r = 0.25, 0.24 and 0.16, respectively) to the individual motility of the spermatozoa. The percentage of abnormal spermatozoa tended to decrease as the number of either motile or live spermatozoa increased (r = -0.42, r = -0.30). Significant ($p < 0.05$) variations in semen characteristics were observed between the cocks within the rainy season. Sperm concentration increased from May and peaked in August. The frequency distribution of the semen volume was bimodal with values of 0.13 and 0.38 ml. There was a positive correlation between the semen volume and the total sperm count, which suggested that the sperm output of the local cocks might be improved through selection for higher semen volume (0.38 ml).

■ INTRODUCTION

The local chicken in Nigeria has been studied and its potential for meat and egg production reported (12). It supplies most of the poultry meat consumed in the country. It is assumed that there is only one type of local chicken in Nigeria even though the Hausa and Fulani settlers in Northern Nigeria recognize by name at least 15 varieties of local chickens (6).

The local chicken is present in village economies. It lives off carrion and is exposed to unplanned breeding, a harsh environment and diseases. It has a light body weight, lays small eggs, reaches maturity early and is nonetheless well adapted to its harsh environment and disease exposure (12). Nwosu and Omeje reported that local cocks possessed dominant genes for egg production, early maturity and hardiness of pullets and that their offspring survived better than those of exotic breeds (13). Different methods have been described on semen collection from chicken (18) and on factors affecting semen quality (2, 4, 14, 17). Semen characteristics of some breeds of cocks have been reported (7, 10, 11, 18).

In Nigeria, semen from some exotic breeder cocks were characterized (11). Seasonal variation in the semen quality of guinea fowl was recorded (16), as well as the fertility and hatchability of eggs from exotic hens inseminated with semen from local cocks (15). The fertility (45.8%) and hatchability (37.5%) were low indicating that further studies were required to determine semen quality and responsible factors. There is no report on the semen quality and quantity of the local cocks in the Sahel region of Nigeria. The aim of this project was therefore to study the characteristics of semen and sperm output of the local cocks in the Sahel region of Nigeria.

■ MATERIALS AND METHODS

Seventeen local breeder cocks (50-86 weeks old) weighing 1.15 to 2.14 kg were randomly purchased from local chicken breeders in Maiduguri in the Sahel region. The cocks were dewormed with albendazole (Samzole®, Animal Care), caged individually in 1.0 ft^3 cages and fed with growers' mash.

The semen was collected from the cocks by the abdominal massage method (3). Collections were on Mondays, Wednesdays and Fridays between 8:00 and 10:00 am from May to September 1998 during the rainy season. The rainy season is short while the long dry season is characterized by the cold dry (hamattan) period followed by the hot dry period. Table I shows weather characteristics during the period of the study.

1. Catholic Mission Njindom, PO Box 31, Mbengwi, Momo Division, North West Province, Cameroon

2. Department of Veterinary Surgery and Reproduction, Faculty of Veterinary Medicine, University of Maiduguri, PMB 1069, Maiduguri, Nigeria

Table I

Mean weather characteristics in Maiduguri in 1998

	Max. temp. (°C)	Min. temp. (°C)	Rainfall (mm)	Relative humidity
April	42.0	24.6	0	26
May	40.0	27.1	4.5	4.2
June	38.4	26.2	108.4	49
July	31.3	23.2	210.2	70
August	32.6	23.0	230.4	69
September	34.0	23.1	96.6	64
October	38.1	21.6	12	31
November	37.4	19.1	0	20
Total annual rainfall			662.1	

A graduated centrifuge tube (10 ml) was used to collect the semen, from which semen volume and color were recorded. A pH paper (ROTA®, M&B) was used to record the pH. The wave pattern, individual motility, percentages of live/dead and abnormal/normal spermatozoa were evaluated as described by Zemjanis (20). Eosin/nigrosin stains were used on smears for live/dead and abnormal/normal sperm cell counts. The smears were then dried on a warmer slide and observed immediately with a light microscope at high power magnification (x 1000). Dead cells picked up the eosin stain, while live cells did not. An improved Neubauer hemocytometer and red blood cell pipette were used to determine sperm concentration (3), while 1% formal saline was used as spermicidal diluent for semen. Sperm count was done as described by Hafez (3) with a light microscope (x 400). Sperm concentration was calculated by multiplying the number of sperm cells counted by the multiplying factor of the chambers counted and the dilution factor of the semen. Total sperm count was then calculated by multiplying sperm concentration by semen volume (3).

Data were summarized as mean plus or minus the standard deviation. Correlation coefficients between parameters and analysis of variance between cocks and within season were computed using SPSS software.

■ RESULTS

Data on semen characteristics are presented in Table II and the frequency distribution of sperm concentration, total sperm count and semen volume in Figures 1, 2 and 3, respectively. Significant variations ($p < 0.001$) were observed in the eight semen characteristics (sperm concentration, total sperm count, semen volume, live sperm, individual motility, gross motility, pH and abnormal spermatozoa) between the local cocks (Table III). These variations did not however follow any phenotypic line of the cocks.

The concentration of sperm in the semen of the local cocks was normally distributed with a modal class of 1.75-2.00 x 10^9 sperm/ml. The majority of the ejaculates had less than 1.25 x 10^9 spermatozoa and clustered around 0.50-0.75 x 10^9 sperm per ejaculate class. The distribution of total sperm count per ejaculate of the local cocks was skewed to the right. A similar distribution was also observed in the percentage of abnormal sperm and in the semen volume. The semen volume was also bimodally distributed with 0.13-0.19 ml and 0.38-0.44 ml as modal classes. The frequency distributions of percentage of live spermatozoa, individual motility and gross motility showed negative skewness with modal classes at 90-92.5%, 80-90% and 3.0-4.0%, respectively. The pH of 86% of the ejaculates was 7.5, while it was 7.0 for the remaining 14%. The semen color varied between opalescent (5.5%), milky (45.9%) and creamy-white (48.6%).

The percentage of abnormal spermatozoa tended to decrease as the number of either motile or live spermatozoa increased. Significant positive correlations (Table IV) existed between individual motility and sperm concentration or total sperm count and between semen volume and total sperm count. Semen volume, sperm

Table II

Semen characteristics of local cocks in the Sahel region of Nigeria (n = 299)

Parameter	Mean ± SD	Range
Semen volume (ml)	0.28 ± 0.14	0.05-0.75
Sperm concentration (x 10^9 spermatozoa/ml semen)	2.26 ± 1.08	0.003-5.344
Total sperm count (x 10^9 spermatozoa/ejaculate)	0.64 ± 0.44	0.0001-2.99
Abnormal spermatozoa (%)	11.55 ± 8.50	1.3-60.3
Live spermatozoa (%)	86.66 ± 8.4	56.3-99.4
Individual motility (%)	73.9 ± 14.5	10-90
Gross motility	3.2 ± 0.7	0-4
PH	7.4 ± 0.2	7.0-7.5

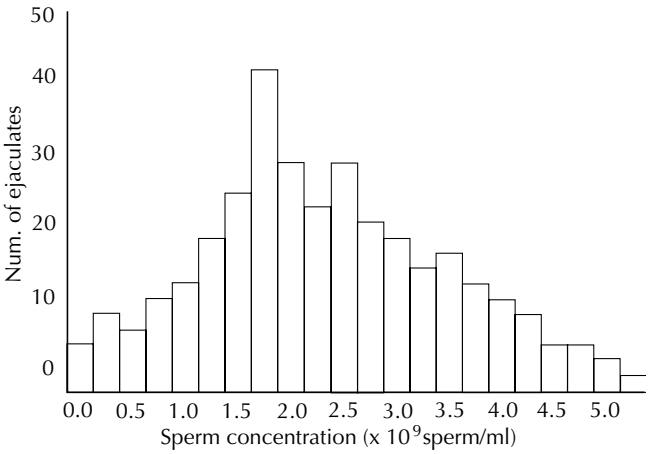

Figure 1: *Distribution of sperm concentration of local cocks in the Sahel region of Nigeria (n = 299).*

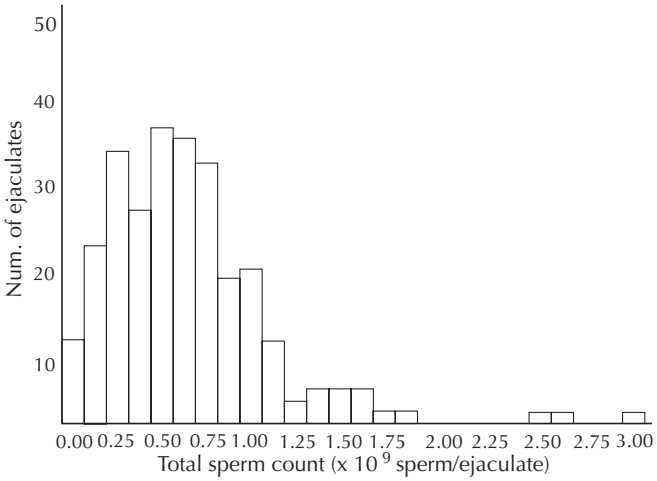

Figure 2: *Distribution of total sperm count of local cocks in the Sahel region of Nigeria (n = 299).*

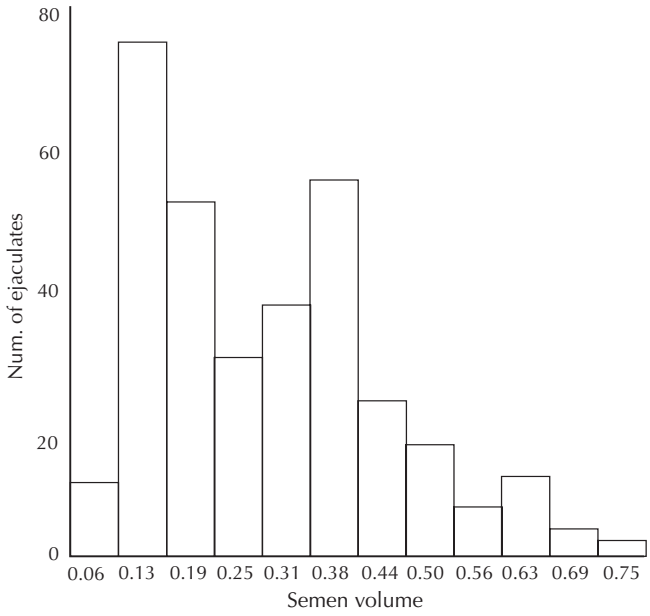

Figure 3: *Distribution of semen volume of local cocks in the Sahel region of Nigeria (n = 299).*

Table III

Analysis of variance (ANOVA) of semen characteristics of local cocks in the Sahel region of Nigeria

Source of variation	Degrees of freedom	Mean squares						
		% abnormal sperm	% live sperm	Sperm concentration	Total sperm	Semen volume	Gross motility	Individual motility
Between cocks	16	419.669**	253.664**	5.599**	0.581**	0.120**	3.378**	1802.455*
Within cocks (error)s	288	48.145	48.144	0.917	0.176	0.012	0.335	118.751

* $p < 0.01$
** $p < 0.001$

Table IV

Correlation coefficient matrix of semen characteristics of local cocks in the Sahel region of Nigeria (n = 299)

	Abnormal sperm	Individual motility	Live sperm	Sperm concentration	Semen volume	Sperm output	Gross motility
Abnormal sperm	1.000						
Individual motility	-0.42 ($p < 0.01$)	1.000					
Live sperm	-0.30 ($p < 0.01$)	0.36 ($p < 0.01$)	1.000				
Sperm concentration	-0.04 ($p > 0.05$)	0.25 ($p < 0.01$)	0.07 ($p > 0.05$)	1.000			
Semen volume	-0.10 ($p > 0.05$)	0.16 ($p < 0.05$)	0.13 ($p > 0.05$)	-0.02 ($p > 0.05$)	1.000		
Sperm output	-0.07 ($p > 0.05$)	0.24 ($p < 0.01$)	0.10 ($p > 0.05$)	0.61 ($p < 0.01$)	0.66 ($p < 0.01$)	1.000	
Gross motility	-0.31 ($p < 0.01$)	0.78 ($p < 0.01$)	0.25 ($p < 0.01$)	0.21 ($p < 0.01$)	0.14 ($p < 0.05$)	0.22 ($p < 0.01$)	1.000

concentration and total sperm count were not significantly correlated to the percentage of morphologically abnormal spermatozoa. There was no significant correlation between sperm output and live body weight of the cocks.

Semen characteristics varied significantly ($P < 0.001$) during the rainy season (Table V). The highest value of sperm concentration was recorded in July, while those for semen volume and total sperm count in August (Table VI). The semen volume was significantly ($P < 0.05$) higher on Mondays than on Fridays, while sperm concentration was the opposite (Table VI). However, these variations did not affect the total sperm count per ejaculate between the collection days. Statistical analysis indicated significant variations in semen volume between cocks. The mean semen volume equal to or greater than 0.32 ml was significantly higher ($P < 0.05$) than that with lesser volumes.

■ DISCUSSION

Semen evaluation is an essential aspect in the assessment of the breeding soundness of any male animal. Values have been denoted for each of the semen characteristics above or below which the semen may be judged to be good for artificial insemination (AI) provided that certain sperm defects associated with sterility or infertility are not present (3, 20). The local cocks possessed dominant genes for egg production, early maturity of pullets and hardiness (13) and, when crossed with exotic hens, their offspring survived better than those of the reversed pairing.

Values of semen characteristics of the local cocks were within the acceptable range for AI (3). However, the semen volume and sperm output were on the lower side of the acceptable range (0.2-0.5 ml and 0.6-3.5 billions, respectively). High sperm output makes breeding economical (high female to male ratio) and AI feasible. A 0.05 ml aliquot of whole semen (19) or 100-200 million viable chicken spermatozoa (3) are needed per insemination for high fertility to be maintained. Significant differences were observed between the local cocks in all the semen characteristics. This was expected because of the heterogenetic nature of the local chickens, which are yet to be classified in the breeds.

The mean semen volume of 0.32 ml and above was significantly higher ($P < 0.05$) than that with lower values, and the distribution of the semen volume indicated two groups of ejaculates. Since the semen volume was positively correlated with the total sperm count, selecting local cocks for higher semen volume could also select them for higher sperm output. The relationship between semen volume and production trait is yet to be established. A two-way analysis of variance indicated that the semen volumes were significantly influenced by the day and month of collection.

Table V

Two-way ANOVA of some semen characteristics of local cocks in the Sahel region of Nigeria during the rainy season

Sources of variation	Degree of freedom	Mean squares			
		Sperm concentration	Total sperm count	Semen volume	Individual motility
Between months	4	20.05 ($p < 0.01$)	0.92 ($p < 0.01$)	0.16 ($p < 0.01$)	1454.93 ($p < 0.01$)
Between days of collection	2	3.41 ($p < 0.05$)	0.001 ($p > 0.05$)	0.06 ($p < 0.05$)	60.63 ($p > 0.05$)
Within subgroup and residual	299	0.9	0.19	0.02	191.15

Table VI

Mean values of semen characteristics of local cocks in the Sahel region of Nigeria with respect to days and months of semen collection

Variables	Means ± standard deviation			
	Sperm concentration (x 10^9 sperm/ml)	Total sperm count (x 10^9 sperm/ejaculate)	Semen volume (ml)	Individual motility (%)
Grand mean	2.262 ± 1.098^{c}	0.642 ± 0.440	0.28 ± 0.14^{ab}	73.85 ± 14.46
Mondays	2.422 ± 1.085^{c}	0.638 ± 0.493	0.25 ± 0.14^{a}	72.87 ± 14.95
Wednesdays	2.219 ± 1.123^{c}	0.640 ± 0.403	0.28 ± 0.13^{ab}	75.05 ± 13.99
Fridays	2.055 ± 1.064^{b}	0.628 ± 0.426	0.30 ± 0.14^{b}	74.04 ± 14.51
May	0.932 ± 0.700^{a}	0.281 ± 0.245^{a}	0.26 ± 0.14^{ab}	77.22 ± 5.65^{bc}
June	2.144 ± 1.184^{c}	0.518 ± 0.436^{b}	0.22 ± 0.10^{a}	66.47 ± 14.94^{a}
July	2.814 ± 1.003^{d}	0.691 ± 0.371^{c}	0.24 ± 0.11^{a}	71.65 ± 16.87^{b}
August	2.401 ± 0.992^{c}	0.749 ± 0.502^{c}	0.32 ± 0.16^{b}	78.04 ± 8.62^{c}
September	1.730 ± 0.814^{b}	0.629 ± 0.457^{cb}	0.32 ± 0.14^{b}	78.29 ± 12.63^{c}

[a, b, c, d] Mean values in the same column with different superscripts are significantly different ($P < 0.05$)

The concentration of spermatozoa in the semen of the local cocks was higher than 1.2 billion (11), 2.0 billion (7, 18) sperm/ml semen but lower than 4.1 billion sperm/ml (8, 10) in broiler cocks and 7.0 billion sperm/ml (3) that were reported. The percentage of live spermatozoa of the local cocks was similar to values reported for the Deshi fowl and its hybrids (18) but lower than 93.8 and 97% reported by Holeppagol *et al.* (5) and Bajpai (1), respectively. Sperm motility tended to have a negative relationship with abnormal spermatozoa. The observed sperm abnormalities (double head, looped head, knotted head and double tail) indicated disturbances of spermatogenesis. It may be necessary to carry out fertility trials on the effects of these abnormalities on the fertility of the local cocks, though the mean value of the percentage of abnormal spermatozoa was similar to previously reported values (5, 7, 18).

Unsuccessful attempts were made to collect artificially semen in March, April and early May, when the maximum daily room temperature varied between 40-43°C with no rainfall. When it started raining in late May, the ambient temperature gradually dropped from 40 to 31.3°C in July and increased to 38.1°C in October; similarly, semen characteristics improved in quality. The seasonal variation in semen traits of guinea fowls (16) in Nigeria is attributed to changes in temperature, rainfall and relative humidity. An elevated body temperature (41.8°C) does not affect spermatogenesis in chickens (8). But when the ambient temperature goes up to 43°C, infertility due to heat stress is not uncommon. Frequency of semen collection may affect semen characteristics (9). McDaniel and Sexton (9) reported that a 48-hour interval is required for long-term collection of semen from chicken. More frequent collection (daily) could be used if semen is to be collected for a short time only to avoid exhaustion of the animal. The collector effect does not significantly affect semen characteristics, although over stimulation tends to increase semen volume and decrease sperm concentration (2).

■ CONCLUSION

The semen quality of local cocks in the Sahel region of Nigeria did not differ much from those reported in other breeds of chickens. However, it is important to select cocks with higher semen volume and total sperm count for breeding to obtain higher fertility. June, July and August seem to be the best breeding period for Sahelian chickens.

Acknowledgments

We are thankful to Mr Gabriel Opahiwa for his assistance in the laboratory.

REFERENCES

1. BAJPAI P.K., 1963. The effect of photoperiodicity on semen characteristics of poultry. *Poult. Sci.*, **42**: 462-465.

2. BENOFF F.H., ROWE K.E., FOUQUAY J.I., RENDEN J.A., ARSCOTTE G.H., 1981. Effect of semen collector on semen volume and sperm concentration in broiler breeder males. *Poult. Sci.*, **60**: 1062-1065.

3. HAFEZ E.S.E., 1987. Techniques for improving reproductive efficiency. In: Reproduction in farm animals, 5th Edn. Philadelphia, PA, USA, Lea and Febiger, p. 455-497.

4. HOCKING P.M., BERNARD R., 1997. Effects of dietary crude protein content and food intake on production of semen in two lines of broiler breeder males. *Br. Poult. Sci.*, **38**: 199-202.

5. HOLEPPAGOL S.S., SIDHU N.S., BISHT G.S., 1994. Genetic group comparisons in live (normal) and dead (included abnormal) percentages of poultry spermatozoa. *Indian vet. Med. J.*, **18**: 88-91.

6. IBRAHIM M.A., ABDU P.A., 1992. Ethnoagro-veterinary perspectives of poultry management, health and production among the Hausa/Fulani of rural Nigeria. In: Proc. 29th Annu. Gen. Meet. Niger., Vet. Med. Assoc., Kaduna, Nigeria, 27-30 October 1992, p. 172-181.

7. KESKIN O., TEKIN N., KGAY E., 1995. The principal spermatological characteristics of Denizli cocks. *Hay Vancilik Arastirma Ens. Derg.*, **35**: 87-99.

8. McDANIEL C.D., BRAMWELL R.K., WILSON J.L., HOWARTH B. JR, 1995. Fertility of male and female broiler breeders following exposure to elevated ambient temperature. *Poult. Sci.*, **74**: 1029-1038.

9. MCDANIEL G.R., SEXTON T.J., 1977. Frequency of semen collection in relation to semen volume, sperm concentration and fertility in the chicken. *Poult. Sci.*, **56**: 1989-1993.

10. MOYA A., GONZALEZ M., CAPOTE M., 1996. Selection of white Leghorn cocks for artificial insemination. 1. Sire semen evaluation. *Rev. cubana Cienc. avicola*, **20**: 71-75.

11. NWAGU B.I., REKWOT P.I., ABUBAKAR B.Y., ONI O.O., ADEYINKA I.A., EGBUEDO U.C., 1996. Semen characteristics of Rhode Island red and white breeder cocks. *Niger. Anim. Prod.*, **23**: 1-4.

12. NWOSU C.C., 1979. Characterisation of the local chicken in Nigeria and its potential for egg and meat production. In: Olomu J.M., Offiong S.A., Buvanendra V., Osinowo O.A., Eds, Proc. 1st Nat. Semin. Poult. Prod., Zaria, Nigeria, 11-13 December, p. 187-210.

13. NWOSU C.C., OMEJE S.S., 1983. Heterosis of short term egg production on animal production, Vol. 2. Nigeria, p. 109-110.

14. OMEJE S.I., UDE I., 1998. Effect of feed restriction on body weight and semen characteristics of native (broiler) cocks. *J. appl. Anim. Res.*, **14**: 81-86.

15. ONUORA G.I., 1979. Preliminary report of the use of artificial insemination between Nigerian cocks and exotic hens. *Niger. vet. J.*, **8**: 20-21.

16. ONUORA G.I., 1982. Seasonal variation in semen quality in the guinea fowls. *Niger. vet. J.*, **11**: 8-15.

17. SAEID J.M., AL-SOUDI K.A., 1975. Seasonal variation in semen characteristics of white Leghorn, New Hampshire and indigenous chicken in Iraq. *Poult. Sci.*, **16**: 97-102.

18. SARKA R., GHOSH B.B., BANDOPADHYAY S.K., CHOUDHURY R.R., GUPTA R.D., 1996. A study on the physical characters of semen of hybrid (broiler and layer) and Deshi cross fowl. *Indian Anim. Reprod.*, **17**: 55-57.

19. SMYTH J.R. JR, 1968. Perry E.J. Ed., Poultry in the artificial insemination of farm animal, 4th Edn. Piscataway, NJ, USA, Rutgers University Press, p. 258-300.

20. ZEMJANIS R., 1970. Diagnostic and therapeutic technique in animal reproduction, 2nd Edn. Baltimore, MD, USA, The Williams and Wilkins Company, p. 139-155.

Reçu le 18.05.2000, accepté le 28.09.2001

Résumé

Bah G.S., Chaudhari S.U.R., Al-Amin J.D. Caractéristiques du sperme de coqs d'élevage locaux de la région sahélienne du Nigeria

Les caractéristiques du sperme de coqs locaux de la région sahélienne du Nigeria (âgés de 60,9 ± 10,6 semaines) ont été enregistrées de mai à septembre 1998. Les valeurs moyennes ont été de 0,28 ± 0,14 ml pour le volume du sperme, 2,26 ± 1,08 x 10^9 spermatozoïdes/ml pour la concentration du sperme, 0,64 ± 0,44 x 10^9 spermatozoïdes par éjaculat, 86,6 ± 8,4 p. 100 pour les spermatozoïdes vivants, 73,9 ± 0,2 p. 100 pour la motilité individuelle, 7,4 ± 0,2 pour le pH et 11,6 ± 8,5 p. 100 pour les spermatozoïdes anormaux. Les valeurs de la concentration du sperme, du nombre de spermatozoïdes total et du volume du sperme ont été corrélées positivement (valeurs respectives de r : 0,25, 0,24 et 0,16) à la motilité individuelle des spermatozoïdes. Le pourcentage de spermatozoïdes anormaux a eu tendance à diminuer lorsque le nombre de spermatozoïdes mobiles ou vivants a augmenté (r = -0,42, r = -0,30). Des variations significatives ($p < 0,05$) dans les caractéristiques du sperme ont été observées entre les coqs lors de la saison des pluies. La concentration du sperme a augmenté à partir de mai atteignant une valeur maximale en août. La répartition des fréquences du volume du sperme a été d'ordre binaire avec des valeurs de 0,13 et 0,38 ml. Il y a une corrélation positive entre le volume du sperme et le nombre total de spermatozoïdes, suggérant que le nombre de ces derniers chez les coqs locaux peut être amélioré par la sélection du volume de sperme le plus important (0,38 ml).

Mots-clés : Poulet - Coq - Sperme - Variation saisonnière - Sahel - Nigeria.

Resumen

Bah G.S., Chaudhari S.U.R., Al-Amin J.D. Características del semen de gallos de cría locales en la región Sahariana en Nigeria

Se registraron las características del semen de gallos locales (60,9 ± 10,6 semanas de edad) en la región del Sahara en Nigeria, entre mayo y setiembre de 1998. Los valores (± SD) medios fueron: volumen de semen 0,28 ± 0,14 ml, concentración de espermatozoides 2,26 ± 1,08 x 10^9 espermatozoides/ml, conteo total de espermatozoides 0,64 ± 0,44 x 10^9 espermatozoides/eyaculado, porcentaje de espermatozoides vivos 86,6 ± 8,4%, motilidad individual 73,9 ± 0,2%, pH 7,4 ± 0,2 y espermatozoides anormales 11,6 ± 8,5%. Se encontró una correlación positiva entre la concentración espermática, el conteo total de espermatozoides y el volumen de semen (r = 0,25, 0,24 y 0,16, respectivamente) con la motilidad individual de los espermatozoides. El porcentaje de espermatozoides anormales mostró tendencia a disminuir conforme el número de espermatozoides móviles o vivos aumentó (r = -0,42, r = -0,30). Se observaron variaciones significativas ($p < 0,05$) en las características del semen entre gallos durante la estación lluviosa. Las concentraciones de esperma aumentaron a partir de mayo, con un pico en agosto. La distribución de la frecuencia del volumen de semen fue bimodal, con valores de 0,13 y 0,38 ml. Se observó una correlación positiva entre el volumen de semen y el conteo total de espermatozoides, lo que sugiere que la salida de esperma de los gallos locales puede mejorar a través de la selección para mayores volúmenes de semen (0,38 ml).

Palabras clave: Pollo - Gallo - Semen - Variación estacional - Sahel - Nigeria.