Sperm morphology in relation to semen cation concentration in Yankasa rams

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Abstract

The morphological appearance of sperm cells is a major criterion in semen evaluation. The optimal production of semen of high biological value is influenced by numerous factors. Therefore, a study was conducted to evaluate the relationship between sperm morphological characteristics and semen cation concentrations in 62 rams of Yankasa breed of sheep. Semen samples were collected from each animal on weekly basis for 52 weeks with electro-ejaculator. The sperm morphological characteristics examined were: detached mid-piece and tail (DMT), detached head (DH), mid-piece droplet (MPD, coiled and bent tail (CBT) and acrosomal abnormality (ACR). The semen cation parameters measured were: sodium ion (Na^+), potassium ion (K^+) and calcium ion (Ca^{2+}). Pearson correlation matrix of SAS was used to determine the relationships among and between the measured characteristics. The result of the study showed that correlations among the sperm morphological characteristics were low and not significant except that between DH and DMT which was perfect ($p < 0.01$; $r = 1.00$). On the other hand, semen cation concentrations were positively correlated but not significant among themselves except the correlation between Na^+ and K^+ ($p < 0.01$; $r = 0.37$) which was significant. Relating the semen cation concentration with sperm morphological characteristics, it was discovered that potassium ion (K^+) measured was negatively and significantly correlated with all the morphological attributes (DMT & DH, $r = -0.36$ @ $p < 0.01$; CBT & ACR, $r = -0.38$ @ $p < 0.05$; MPD, $r = -0.32$ @ $p < 0.05$). It was concluded that DH is highly associated with DMT while Na^+ concentration was an indicator for K^+ level in the semen as shown in the result. Also, the higher the potassium ion in semen, the lower the level of sperm morphological abnormalities and vice versa in Yankasa rams.

Keywords: Sperm morphological characteristics, semen cation concentrations, Yankasa rams

Introduction

The morphological appearance of sperm cells is a major criterion in semen evaluation. It is the most important qualitative characteristics of semen (Kuster *et al.*, 2004). It is the basic indicator for predicting the fertilizing ability of spermatozoa, based upon correlation between particular categories of spermatozoa and fertility results (Lucas-Zewiez, 1998). Examination of sperm morphology and determination of number of spermatozoa with morphological defects play a significant role in semen quality assessment, thus enabling the elimination of males with potentially low fertility prior

to the preservation of their semen (Rodriguez-Martinez and Barth, 2006). Among the reproductive traits, quality semen plays a major role in determining the fertility and reproductive efficiency of any livestock production. The optimal production of semen of high biological value is influenced by numerous factors, including: breed (Kondracki *et al.*, 2007; Smital *et al.*, 2004), season of the year (Ciereszko *et al.*, 2000; Wysokinska *et al.*, 2005), age of the animal, and frequency of sperm collection (Deka *et al.*, 2002). Primary abnormalities originated in the testis during spermatogenesis during the development of the testicular tubules while

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secondary abnormalities originated in the epididymis due to changes taking place during storage in the epididymis. Tertiary abnormalities are those arising from poor handling techniques (Rao and Rao, 1980). Semen volume, sperm motility and sperm concentration have been reported to be negatively correlated with abnormal spermatozoa in Yankasa rams (Suleiman and Adu, 2012a; Akpa *et al.*, 2012a and Akpa *et al.*, 2012b). Reddy *et al.* (1975) also reported significant negative correlation between abnormal spermatozoa and conception rate.

Cation concentrations in the seminal plasma provide the congenial milieu for the survival of sperms (Kalita *et al.*, 2006). The concentrations of different ions in seminal plasma also reflect the quality of semen and physiological status of reproductive accessory gland (Kalita *et al.*, 2006). Calcium is important for semen physiology including motility and glycolysis (Morton *et al.*, 1987), metabolism (Peterson and Freund, 1976), acrosome reaction and fertility (Yanagimachi, 1981). Sodium is an extracellular element while potassium is intracellular in nature. Therefore, the objective of this study was to determine the relationships between sperm morphological characteristics and semen cation concentrations in Yankasa rams.

Materials and methods

Study location

The study was conducted at the Experimental and Research Farm of the Department of Animal Science, Ahmadu Bello University, Zaria located within the northern Guinea savanna between latitude 11° and 12°N and on altitude of 640m above sea level (Akpa *et al.*, 2002). The area has two seasons; dry season (November to April) and rainy season (May to October). An average annual maximum temperature of 33.17±0.67°C and 18.74±0.63°C

characterize the climate of the area.

Experimental animals and management

A total number of 62 Yankasa rams were used for the study. The animals were under the management of the Department of Animal Science, Ahmadu Bello University, Zaria at semi-intensive level of production. They were subjected to dipping against ectoparasite as well as anti-helminthis through drenching (deworming) and vaccination against endemic diseases. The rams were at three age categories; 12-18, 19-24 and 25-36 months.

Semen collection and evaluation

Semen samples were collected from 62 rams using electro-ejaculator and labelled accordingly. These were taken on weekly basis for 52 weeks of the experiment. Smear of each semen sample was prepared, air-dried and labelled to examine sperm morphological abnormalities. After cleaning the smeared slides with oil immersion, they were placed on electronic microscope and the total number of abnormal cells were counted using hemocytometer and recorded. Types of abnormalities observed were detached mid-piece and tail (DMT), detached head (DH), mid-piece droplet (MPD), coiled or bent tail (CBT) and acrosome (ACR) (acrosome membrane detached, acrosome outline and acrosome cap defect). The remaining semen samples were immediately taken to Pathological Department of ABU Teaching Hospital for mineral analysis where Coleman 21 Flame Photometer was used for mineral analysis. The cation analyzed were Calcium (Ca^{2+}), Sodium (Na^+), Potassium (K^+) and Phosphate ions (PO_4).

Data analysis

Correlation analysis procedure (Pearson correlation) of SAS (2002) was used to assess the relationship between the semen abnormalities and semen cation concentration.

Results and discussion

The result of the relationship among sperm morphological characteristics is presented in Table 1. The relationship was generally low and not significant, except between DH and DMT which may have indicated perfect relationship ($P < 0.01$; $r = 1.00$). This signifies that all the abnormal spermatozoa

showing DMT have a corresponding DH in the semen samples. The CBT was negatively related to other abnormalities but not significant. These results are in agreement with Ambali *et al.* (2018) who also reported perfect relationship in the same attributes in Red Sokoto bucks and Cevik *et al.* (2007) who reported $r = 0.45$ in bulls.

Table 1: Correlation coefficients (r) among sperm morphological traits in Yankasa rams

Traits	MPD	DH	CBT	ACR
DMT	0.02	1.00*	0.20	0.13
MPD		0.20	0.09	0.04
DH			0.20	0.13
CBR				0.08

DMT – Detached Midpiece and Tail, MPD – Midpiece Droplet, DH – Detached Head, CBT – Coiled and Bent Tail, ACR – Acrosome (all at $\times 10^6$). ** - $p < 0.01$.

Table 2 shows the result of the relationship among semen cation concentrations. The relationships were positive but non-significant except the relationship between sodium ion and potassium ion ($r = 0.37$; $P < 0.01$) which was significant. The moderate, positive and significant relationship between the two ions may confirm their responsibility in maintaining osmolarity and metabolic activities of the

spermatozoa in seminal fluid. This assertion agrees with Ambali *et al.* (2018) who reported $r = 0.30$ in Red Sokoto bucks and Quinn *et al.* (1965) who reported $r = 0.51$ in their study on the distribution of the major cations in semen and male accessory secretions. Nath (1988) also reported a positive and significant relationship between the two ions in buffalo semen.

Table 2: Correlation coefficients (r) among semen cation concentration in Yankasa rams

Cation	Potassium ion	Calcium ion	Phosphate ion
Sodium ion	0.37**	0.07	0.14
Potassium ion		0.12	0.02
Calcium ion			0.02

** - $p < 0.01$.

The result of the relationship between sperm morphological characteristics and semen cation concentration is presented in Table 3. In the result, only potassium ion had a negative and significant relationship with sperm abnormalities ranged between -0.32 to -0.38. This is an indication that an increase in potassium ion in the seminal

fluid will result into a corresponding decrease in the occurrence of sperm defect in the rams. The result is in consonance with the reports of Nath, (1988) on buffalo semen in India, Akpa *et al.* (2013) on semen from Red Sokoto bucks in northern Nigeria and Ambali *et al.* (2018) who reported the relationships between similar variables in *Capra aegagrus hircus*.

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Table 3: Correlation coefficients (r) between sperm morphology and semen cations concentration in Yankasa rams

Cation/morphology	DMT	MPD	DH	CBT	ACR
Sodium ion	0.40	0.06	0.04	0.11	0.09
Potassium ion	0.36**	0.32**	0.36**	0.38*	0.38*
Calcium ion	0.08	0.01	0.08	0.05	0.11
Phosphate ion	0.13	0.10	0.13	0.32	0.05

** - $p < 0.01$. * - $p < 0.05$. DMT – Detached Midpiece & Tail, MPD – Midpiece Droplet, DH – Detached Head, CBT – Coiled & Bent Tail, ACR – Acrosome (all at $\times 10^6$).

Conclusions

The study showed that with the knowledge of cation concentration in semen, it is possible to determine the amount of sperm morphological abnormalities inherent in them. The report of this study could be applied in animal reproduction and breeding most especially as a guide to selection in order to give a desired selection response and appropriate genetic gain from selection.

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