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The variation of age, hair type and body condition score with sperm morphology and cation concentration in yankasa ram

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ABSTRACT

The study was conducted to determine the variations of age, hair type and body condition score with sperm morphology and cations concentration in 62 Yankasa rams. The results revealed that the average abnormal morphological characteristics of ram semen were; 0.68, 0.47, 0.68, 0.47 and 0.36, respectively for detached midpiece and tail (DMT), midpiece droplet (MPD), detached head (DH), coiled and bent tail (CBT) and acrosome (ACR). Age, hair type and body condition score had significant ($P<0.01$) effect on sperm morphology except the effect of age on ACR and effect of BCS on MPD and ACR ($P>0.05$). DMT and DH were more frequent in younger rams of between 12 and 24 months of age than rams of later ages. On the other hand, the problem of MPD was more frequent on rams of 25 to 36 months of age. The CBT was observed more in rams that were between 19-24 months of age. With respect to hair type, the long-smooth haired rams had the highest DMT and DH abnormalities (1.0×10^6), while the short-smooth haired rams had the highest MPD abnormalities (0.6×10^6) while long curly hair type had the highest CBT spermatozoa (0.7×10^6). However, the short-rough rams showed none of the sperm morphological abnormalities. Age, hair type and body condition score also had significant ($P<0.01$) effect on semen cation concentrations except the effect of BCS on Na and K ions. The result of this experiment showed that age, hair type and body condition score are important factors in selecting breeding rams for optimum performance.

Introduction

The morphologic 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 may be the basic indicator for predicting the fertilizing ability of spermatozoa (Lukas-Zewiez, 1998). Sperm morphology can serve as an indicator of some disorders in spermatogenesis.

Composition of semen has been analyzed in many species, ruminant inclusive, for the study of various biochemicals and enzymatic constituents of semen (Prasad *et al.*, 2000). Among the most important aspects of the study on spermatozoa metabolism is the understanding of the chemical pathways involved in energy metabolism (White, 1958) and maintenance of osmotic balance by ion present in semen (Nath, 1988) which are important determinants of sperm viability. Calcium is important for semen physiology including motility (Morton *et al.*, 1987), metabolism (Peterson and Freund, 1976), acrosome reaction, and fertilization (Yanagimachi, 1981). However, Magnus *et al.* (1990) reported no association between ionized calcium concentrations and the proportion of spermatozoa displaying progressive movement. Prien *et al.* (1990) compared sperm motility, velocity and progressive movement with total and ionized calcium. The ions present in the semen helps in stimulating the motility and glycolysis. Sodium is an extracellular element while potassium is intracellular in nature, and there is an opinion that normal ionic equilibrium and osmotic pressure are maintained by these ions (Hawk *et al.*, 1964).

This study therefore, was aimed at determining the effect of age, hair type and body condition score on sperm morphological abnormalities and cation concentration, and their relationships in Yankasa ram.

Materials and Methods

The study was conducted at the Research Farm of the Animal Science Department, Ahmadu Bello University, Zaria, located within the Northern Guinea Savannah zone, between latitude 11^o and 12^o N and on altitude of 640m above sea level (Akpa *et al.*,2002). Sixty-two Yankasa rams were used for this study. The ages of the rams were categorized into three as thus; 12-18, 19-24 and 25-36 months. The hair types which were determined through touching and feeling were categorized according to the length and texture of the hairs as thus; short-smooth (SS), long-curly (LC), long-smooth (LS) and short-rough (SR). The body condition was scored on a scale 1 to 5 as described by Allen, (1990).

Semen samples were collected from each animal using electro-ejaculator and labeled accordingly. Smear of each semen sample was prepared, air-dried and labeled to examine sperm morphological abnormalities. After cleaning the smeared slides with oil immersion, they were placed on an electronic microscope and the total number of abnormal cells were counted using counter and recorded. Types of abnormalities observed were; detached mid-piece and tail (DMT), detached head(DH),

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mid-piece droplet(MPD), coiled and bent tail(CBT), and acrosome (ACR) (acrosome membrane detached, acrosome outlines and acrosome cap defect). The remaining semen samples were immediately taken to Pathological Department of Ahmadu Bello University Teaching Hospital, Shika, Zaria, for mineral analysis. The cations analyzed were Sodium (Na^+), Calcium(Ca^{2+}), Potassium (K^+) and Phosphate ions(PO_4)

Data Analysis

The data were summarized using descriptive statistics and the effect of age, hair type and body condition score on the assessed semen characteristics were determined using general linear model (GLM) procedure of SAS. (SAS, 1998) Correlation analysis procedure of SAS (1998) was used to assess the relationship between the variables.

The model used is as follows:

$Y_{ijk} = \mu + A_i + H_j + C_k + E_{ijk}$

Where : Y_{ijk} = estimates of the given measurable characteristics

μ = over all mean

A_i = effect of i^{th} age (i: 12-18, 19-24 and 25-36)

H_j = effect of j^{th} hair type (j: SS, LC, LS and SR)

C_k = effect of k^{th} body condition score (k = 1, 2….5)

E_{ijk} = random error.

Results

The average abnormal morphological characteristics of ram semen were; 0.68, 0.47, 0.68, 0.47 and 0.36, respectively for detached midpiece and tail (DMT), midpiece droplet (MPD), detached head (DH), coiled and bent tail (CBT) and acrosome (ACR). These characteristics varied widely with the CV ranging from 83.57 to 135.94%. The mean semen cation concentration was 92.58, 68.34, 2.51 and 4.56 millimol/litre for sodium (Na), potassium (K), calcium (Ca) and phosphate (P) ion, respectively. The variability was low for calcium ion (9.68%), moderate for sodium ion (17.41%) and high for potassium (32.70%) and phosphate ion (34.38%).

The effect of age, hair type and body condition score on sperm morphology is shown in Table 2. Age, hair type and body condition score had significant (P<0.01) effect on sperm morphology except the effect of age on ACR and effect of BCS on MPD and ACR (P>0.05). There was high preponderance of DMT, DH and CBT in the younger rams of between 12 and 24 months of age than those of the later ages. On the other hand, MPD was more frequent on rams of 25 to 36 months of age. With respect to hair type, the long-smooth haired rams had the highest DMT and DH abnormalities (1.0×10^6), while the short-smooth haired rams and long curly hair rams had the highest MPD (0.6×10^6) and CBT spermatozoa (0.7×10^6) abnormalities, respectively. However, none of the abnormalities was observed in the short-rough hair rams. With respect to the body condition score, rams with lower body condition score generally showed higher sperm morphological abnormalities (40-80%) than rams with higher body condition score (30-50%).

The effect of age, hair type and body condition score on semen cation concentration is presented in Table 3. Age, hair type and body condition score had significant (p<0.01) effect on semen cation concentrations except the effect of body condition score on sodium ion (Na^+) and potassium ion (K^+). The semen cation concentrations was relatively higher in the older rams 25-36months than the younger rams 12 to 18 months of age. Observations on the hair type of the rams showed that all the hair types exhibited some level of superiority in one or two of the measured semen cation concentrations. The long-curly haired rams were superior in seminal K^+ and phosphate ions (PO_4) but had lower Na^+ and calcium ions Ca^{2+} concentration compared to the others. The long-smooth haired rams were superior for seminal Na^+ and Ca^{2+} but moderate in K^+ and PO_4. The short-smooth haired rams were superior for K^+ and PO_4 but moderate for Na^+ and Ca^{2+} . However, the short-rough haired rams were moderate in all the seminal cations (Na^+, K^+, Ca^+ and PO_4).

The result of the correlation analysis between semen morphological characteristics is presented in Table 4. The correlations amongst the semen morphological characteristics were generally low and not significant, except the correlation between DH and DMT which were perfectly correlated (P<0.01; r=1.00). Although not significant (P>0.05), the correlated relationships between CDT and all other abnormal morphological characteristics were low and negative (r= -0.08 to -0.20).

The result of the correlation analysis between semen cation concentrations is presented in Table 5. The correlation between the semen cations were positive but not-significant except the correlation between Na^+ and K^+ (r= 0.37; P<0.01).

Discussion

The significant influence of age on sperm morphology indicates that age is an important determinant of sperm morphology. Although the sperm abnormalities were presents in all the age categories, it was however more prevalent in the younger than the older rams except for MPD. The presence of sperm abnormalities in all the age categories may probably indicate that sperm abnormalities of any kind could be present in semen irrespective of age category. This result is supported by the report of Sarder *et al.,* (2001); Sarder, (2004) who observed similar situation. The morphological appearance of sperm cells is a major criterion in semen evaluation. Sperm morphology influences conception rate (Perry and Petterson, 1997); therefore, selection of males with greater percentage of normal sperm increases the overall conception rate in a herd.

Since the result of this study showed that sperm abnormalities are imminent irrespective of hair type of the ram, it is an indication that sperm abnormality is a common phenomenon to any semen sample, however the type and number of sperm abnormalities differs with hair type. The variation of the sperm abnormalities with hair type is probably due to the temperature absorbing capacity of the hair, and Hansen *et al.,* (2001) reported that a rise in body temperature affects the viability of spermatozoa. This implies that hair types indirectly affect sperm viability by influencing the body temperature. In this study the short rough haired rams had fewer abnormalities than the others. This is in line with the earlier reports (Gebremedhin *et al.,* 1997; Tumpenny *et al.,* 2000) that short, sleek, thin hair coat improved heat and water vapour conductance through the coat layer in stressful hot and humid environments.

Rams with body condition score of 4 had lower sperm abnormalities compared to score 3. Therefore, it seems that rams with lower body condition score tends to have higher sperm morphological abnormalities.

Observation from this study demonstrated that ions in semen vary in concentration due to the influence of age, hair type and body condition score. Higher calcium content in semen is reported to have a depressing effect on sperm metabolism (Mann and Mann, 1981). This study reported a low calcium

concentration (2.4-2.6 millimol/litre) which agreed with the above report.

Most of the sperm morphological abnormalities were hardly correlated; however DMT was perfectly correlated with DH. This implies that all the abnormal spermatozoa with DMT also had DH, thus increase or decrease in the number of DMT will lead to direct correlated response in the number of DH spermatozoa.

The moderate, positive and significant relationship between sodium ion and potassium ion confirmed the responsibility of the two ions in maintaining osmolarity and metabolic activities of the spermatozoa. This finding agrees with Nath.(1988) which reported a positive and significant correlation between sodium and potassium content in semen.

Conclusion

The result of this experiment showed that age, hair type and body condition score had significant influenced on sperm morphological characteristics and semen cation concentration in Yankasa rams. The high preponderance of sperm abnormalities in the younger rams (12-24 months) than the older rams suggest that rams of advanced age should be used for breeding purpose to achieved optimum performance.

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Table 1: Sperm morphological characteristics and semen cations

	Mean	SE	CV(%)	Min	Max
Detached midpiece & tail	0.7	0.07	83.57	0.00	2.00
Midpiece droplet	0.5	0.07	120.68	0.00	2.00
Detached head	0.7	0.07	83.57	0.00	2.00
Coiled & bent tail	0.5	0.07	114.30	0.00	2.00
Acrosome	0.4	0.06	135.94	0.00	1.00
Sodium (Na) (millimol/litre)	92.6	2.05	17.41	43.00	135.00
Potassium (K) (millimol/litre)	68.3	2.84	32.70	27.80	163.40
Calcium (Ca) (millimol/litre)	2.5	0.03	9.68	1.65	2.79
Phosphate(P04) (millimol/litre)	4.6	0.20	34.38	3.12	9.80

Table 2: Effect of Age, Hair type and Body Condition Score on Sperm Morphology in Yankasa Ram

Factors	N	Detached Midpiece and Tail ($x10^6$)	Midpiece Droplet ($x10^6$)	Detached Head ($x10^6$)	Coiled and Bent Tail ($x10^6$)	Acrosome ($x10^6$)
Age (months)	62	**	**	**	**	Ns
12 – 18	45	0.7^a	0.4^b	0.7^a	0.4^b	0.3
19 – 24	7	0.7^a	0.4^b	0.7^a	0.7^a	0.4
25 – 36	10	0.4^b	0.8^a	0.4^b	0.4^b	0.4
SEM		0.07	0.07	0.07	0.07	0.06
Hair Type	62	**	**	**	**	**
Long –Curly	10	0.4^c	0.2^c	0.4^c	0.7^a	0.2^b
Long –Smooth	7	1.0^a	0.4^b	1.0^a	0.4^b	0.0^c
Short –Rough	8	0.0^d	0.0^d	0.0^d	0.0^c	0.0^c
Short –Smooth	37	0.7^b	0.6^a	0.7^b	0.4^b	0.5^a
SEM		0.07	0.07	0.07	0.07	0.06
Body Condition score	62	**	Ns	**	**	Ns
3	33	0.8^a	0.4	0.8^a	0.6^a	0.4
4	29	0.5^b	0.5	0.5^b	0.4^b	0.3
SEM		0.07	0.07	0.07	0.07	0.06

**=P<0.01;a,b,c means within the same column and factor with different superscripts differ significantly (P<0.05).

Table 3: Effect of Age, Hair type and Body Condition Score on Semen Cation Concentration in Yankasa Ram

Factors	N	Sodium (Na) (Millimol /litre)	Potassium (Millimol /litre)	Calcium (Ca) (Millimol /litre)	Phosphate ($P0_4$) (Millimol /litre)
Age (months)	62	**	**	**	**
12 – 18	45	91.9^b	68.4^{ab}	2.5^b	4.6^a
19 – 24	7	85.1^c	64.2^b	2.5^b	4.6^a
25 – 36	10	98.4^a	72.2^a	2.6^a	4.1^b
SEM		2.0	2.9	0.03	0.20
Hair Type	62	**	**	**	**
Long –Curly	10	84.0^c	69.4^a	2.4^c	4.3^{ab}
Long –Smooth	7	107.0^a	62.0^b	2.6^a	4.0^b
Short –Rough	8	90.0^b	56.7^b	2.5^b	3.6^{bc}
Short –Smooth	37	92.3^b	69.4^a	2.5^b	4.7^a
SEM		1.95	2.89	0.03	0.20
Body Condition Score	62	Ns	Ns	**	**
BCS (3)	33	91.3	66.6	2.5^b	5.0^a
BCS (4)	29	94.2	70.5	2.6^a	4.0^b
SEM		2.1	2.9	0.03	0.2

**=P<0.01;a,b,c means within the same column and factor with different superscripts differ significantly (P<0.05).

Table 4: Correlation Analysis amongst Semen Morphology in Yankasa Ram

	MPD	DH	CBT	ACR
Detached Mid piece and Tail (DMT)	0.02	1.00**	-0.20	0.13
Mid piece Droplet (MPD)	-	0.02	-0.09	0.04
Detached Head (DH)	.	-	-0.20	0.13
Coiled and Bent Tail (CBT)	.	.	-	-0.08

** = P<0.01

Table 5: Correlation Analysis amongst Semen Cation Concentration in Yankasa Ram

	K	Ca	$P0_4$
Sodium (Na)	0.37**	0.07	0.14
Potassium (k)	-	0.12	0.02
Calcium (Ca)	.	-	0.02

** = P<0.01