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Original Article

Variation in Testicular Morphometric Traits in Djallonke Sheep of North and South Ecotypes of Benin and their Relationships with Body Weight and Characteristics

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Abstract

The study aims to determine the variability of testicular morphometric traits in Djallonke sheep reared under traditional system in Benin according to the ecotype and their relationships with their body traits. Data were collected from November 2014 to December 2015 on 21 rams of North ecotype and 24 rams of South ecotype of 12 months old. It appears that chest circumference, back width, pelvis length, paired testes weight, testes length, testes diameter, testes volume, testes density, paired epididymal weight, epididymal length, epididymal volume, and the epididymal density depend on ecotype ($P<0.05$). The highest chest circumference (69.24 vs 73.29 cm), back width (15.78 vs 14 cm) and pelvis length (23.03 vs 16.8 cm) were recorded in the animals of North ecotype ($P<0.05$). similarly, the highest values ($P<0.05$) of paired testes weight, testes length, testes diameter, testes volume, testes density, paired epididymal weight, epididymal length, epididymal volume, and the epididymal density were found in rams of North ecotype (respectively of 300.86g, 6.91 cm, 4.82cm, 146.14 ml, 1.02 g/cm^3, 27.8 g and 20.1 cm). However, the head length, whither's height, scapulo-ischium length, scrotal length, scrotal circumference, epididymal volume and the epididymal density were similar among ecotypes and was respectively on average 18.21 cm; 54.64 cm; 60.61 cm; 14.09 cm; 22.17cm; 15.35ml and 0.87g/cm^3. In sheep of South ecotype, the live weight was strongly and positively associated with scrotal length, scrotal circumference, paired testes weight, testes length, testes diameter, testes volume, paired epididymal weight, epididymal length and epididymal volume ($0.80 \leq r \leq 0.90$; $P<0.001$); while in sheep of North ecotype, the live weight was proportional to scrotal circumference, paired testes weight, testes length, testes diameter, testes volume, paired epididymal weight, epididymal length and epididymal volume ($0.87 \leq r \leq 0.99$; $P<0.001$). Therefore, improve live weigth will improve the gonads traits as a correlated response.

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Introduction

The reports on reared animal genetic resources in the developing countries as Benin shows several importance of reared animal genetic resources (FAO, 2011). The small ruminant production in general and sheep rearing in particular is a widthspread activity in Benin, as in most countries in sub-Saharan Africa (Gbangboché *et al.*, 2005a, SWAC-OECD / ECOWAS 2008; Babatunde *et al.*, 2010). Due to its relative simplicity compared to the rearing of large animals (Vallerand and Blanckaertr, 1975; London and Weninger, 1996), sheep rearing become widthspread over the years with a national herd increasing from 690,000 heads in 2003 to 860,000 heads in 2013 (CountyStat, 2016). Its importance in social terms is well known because it is a source of income for households and sheep is an important source of meat (Fadare *et al.*, 2012), and plays other socio-economic roles especially in the lives of rural dwellers during several occasions and religious events (Tabaski, sacrifice, etc.) or social events (marriage, baptism gifts, dowry, burial, ...) (Bamikole *et al.*, 2001; CTA, 2006; Adjibode, 2012; Lalit *et al.*, 2016). Djallonke sheep is the most reared sheep breed in Benin (Gbangboche *et al.*, 2004) because of its perfect adaptation to the local climatic conditions and its resistance (Mawuena 1987; Gbangboché *et al.*, 2005a, Gbangboché *et al.*, 2005b).

West African Dwarf sheep (WAD) are capable of limiting parasite multiplication and remain productive in tsetse-infested areas where other breeds can't survive without treatment (Ayuk *et al.*, 2014). It is reared in Benin mainly according to traditional rearing system and met alone or generally associated with other animal species in almost all households. However, the productivity of Djallonke sheep in Benin is low (Gbangboché *et al.*, 2005b; Youssao *et al.*, 2008; Adjibode *et al.*, 2016), amongst others, due to a low fertility rate in the breeding herds. Thus to keep up with the increasing demand of meat production and the productivity of sheep, there is a need for sustainable improvement strategies. Improvement of sheep reproductive performance requires effective actions on its various components, with prolificacy being one of the most important (Yakubu and Musa-Azara, 2013). Few studies (Gbangboché *et al.*, 2004; Akouedegni *et al.*, 2013; Awohouedji *et al.*, 2013) are carried on the characterization of Djallonke sheep reared in Benin. Furtheremore, these studies are conducted in station where farming is of semi-modern type (Gbangboché *et al.*, 2004; Akouedegni *et al.*, 2013; Awohouedji *et al.*, 2013). The various data on growth and reproductive performances in Djallonke sheep of Benin are provided by studies focused mostly the fields of feeding and animal health (Hounzangbe-Adote *et al.*, 2001; Aboh *et al.*, 2008; Babatunde *et al.*, 2008; Babatunde *et al.*, 2009; Awohouedji *et al.*, 2013, Doko Allou *et al.*, 2013). The work of Adjibode *et al.*, (2016) on the variability of growth performance in Djallonke dwarf sheep reared on natural pasture in Benin according to the ecotype, sex, season, lambing rank and litter size shows significant differences among ecotypes. If the variability of growth performance of Djallonke sheep according to the ecotype is known, there is however no data on the characterization of reproductive organs of these sheep breed. According to Elmaz *et al.*, (2008), determination of breeding value of candidate breeder rams at a good age based on morphological and physiological breed characteristics is very important and advantageous for improvement of both economic gain of operations and effectiveness of selection.

Testicular measurements and live weight have been reported to generally indicate the production of viable spermatozoa by the male (Agga *et al.*, 2011). The morpho-biometrical analysis of testicular development is of great importance since it is significantly correlated with reproductive activity (Emsen, 2005). Testicular sizes of animals are some good indicators for identification of those with adequate sperm production. The aim of this study was to determine the variability of testicular morphometric traits and their relations with the body size in Djallonke dwarf sheep reared on natural pasture in Benin according to the ecotype.

Materials and Methods

Study Area

The study was carried to investigate the growth performance of Djallonke lambs of North and South ecotypes of Benin reared under village management conditions. The study was thus conducted conjointly at the North and the South of Benin respectively in the departments Atlantic and Borgou. Situated between the latitudes of 6°20' and 12°30’ north and between the longitudes of 1°30’ and 3°45 East, the republic of Benin covers an area of 113440 km^2 with a population of 10448647 inhabitants (INSAE, 2015) and a density of 60 hab./km^2.

The department Atlantic exhibits climatic conditions of sub-equatorial type, characterized by two rainy seasons with an uneven spatial and temporal distribution of rainfall: major (from April to July) and minor (from September to November). These two seasons are separated by a dry season. Average rainfall is close to 1200 mm per year. The monthly average temperatures vary between 27 and 31°C and the relative air humidity fluctuates between 65%, from January to March, and 97%, from June to July. The department Borgou exhibits climatic conditions of Sudan type, characterized by only one rainy season (from April to October) and one dry season (November to March). Average rainfall varies between 900 and 1300 mm per year while the average annual temperature is 26°C with a maximum of 32°C in March and a minimum of 23°C from December to January. The relative humidity varies between 30 and 70%. Vegetation of Borgou department is a diversified savannah where tree density decreases towards the North.

Data Collection

Data on testicles and body morphometric parameters at 12 months old were then collected on 21 Djallonke rams of North ecotype and 24 Djallonke rams of South ecotype of 12 months old, from November 2014 to December 2015. These animals were all raised in a traditional system. Feeding was mainly based on natural pasture. The animals were put on pasture at about 7.30 a.m. and returned to the barns in the afternoon. They were then fed ad libitum a supplementary diet consisting of crop residues according to the traditional system. The sheep were treated for ectoparasites, drenched once every three months and given other veterinary attention when the need appeared. Reproductive tracts of those 45 matured Djallonke rams of 12 months old were obtained after slaughter within the department of Borgou in the North and the department of Atlantic in the South of Benin. The reproductive tracts were then immediately brought to the laboratory covered in ice and were processed on the same day. The material used for data collection was composed of a data file, electronic balances of 40 kg of capability and 20g of accuracy, and usual materials for recording the testicular and body morphometric traits.

The body weight of the rams was recorded using a scale of 40 kg of capability and 20g of accuracy. Scrotal circumference was measured using a tape at the broadest part of the scrotum. Shoulder width was determined with the aid of a tape measure, as the horizontal distance between the processes on the left shoulder and those of the right shoulder blade. Chest circumference was measured by using a measuring tape around the chest, just behind the front legs; body length was measured from the sternum to the aitch bone and hip or pelvis width was measured using a plastic measuring tape, while height at wither was measured vertically from thoracic vertebrae to the ground using a metal ruler.

The epididymis was carefully excised from the testis by ecotype of sheep along the physiological joints. The testes and epididymis was separated free of adhering connective tissues and fats before the records of morphometric parameters. The following parameters were taking: testicular length, testicular diameter, testicular weight, testicular volume, epididymal weight.

Testicles length was measured with the use of flexible tape in cm; testicles diameter was taken with the use of Vernier caliper; testicle volume was measured by the use of water displacement technique according to Alexandrou (2001). Testicular and Epididymal weights were recorded in grams with the use of digital weighing balance. Also the testicular density was obtained by dividing the testicular weight by the testicular volume as the following formula:

Testicular density ($g.cm^{-1}$) = Testes weight (g)/Testes volume (cm^3).

Statistical Analysis

Data collected were analyzed for the effect of ecotype (North and South) using the software Statistical Analysis System (SAS, 2006). Student t-test and the one way analysis of variance (ANOVA) and correlation analysis were done.

The mathematical expression of this model is as follows:

$Y_{ij} = \mu + E_i + e_{ij}$

Where:

Y_{ij}: the morphometric parameter of the animal j, of the ecotype i (North or South);

μ: overall mean;

E_i: fixed effect of ecotype i (North or South);

e_{ij}: Effect of random residual average performance of the animal j, of the ecotype i (North or South).

Results

Testicular and Body Morphometric Traits in Local Djallonke Sheep of North and South Ecotypes of Benin

The variation of testicular and body Morphometric traits in local Djallonke sheep of North and South ecotypes of Benin is given in table 1. It appears that the live weight, head length, Whither's height, scapulo-ischium length, scrotal length, scrotal circumference, mean epididymal volume and the mean epididymal density were not affected by the ecotype of West African Dawarf sheep of Djallonke breed (P>0.05).

Table 1: Variation of Testicular and body Morphometric traits in local Djallonke sheep of North and South ecotypes of Benin**.**

Variables	North (N = 21)		South (N = 24)		ANOVA
	Mean	SE	Mean	SE	
Live Weight (kg)	21.76	0.61	20.41	1.24	NS
Head length (cm)	18.42	0.41	18	0.48	NS
Whither's height (cm)	55.96	0.91	53.33	1.31	NS
Scapulo-Ischium length (cm)	60.85	0.55	60.38	1.19	NS
Chest Circumference (cm)	69.24	0.82	73.29	1.53	*
Shoulder or Back width (cm)	15.78	0.25	14	0.35	***
Pelvis length (cm)	23.03	0.4	16.8	0.41	***
Scrotal length (cm)	14.31	0.3	13.87	0.51	NS
Scrotal circumference (cm)	23.26	0.63	21.08	0.92	NS
Paired testes weight (g)	300.86	8.24	274.29	9	*
Mean testes length (cm)	6.91	0.16	6.09	0.2	**
Testes diameter (cm)	4.82	0.11	4.24	0.13	**
Mean testes volume (ml)	146.14	3.59	128.8	4.27	**
Mean testes density (g/cm^3)	1.02	0.01	1.06	0.01	***
Paired epididymal weight (g)	27.8	0.76	25.34	0.83	*
Mean epididymal length (cm)	20.1	0.55	18.32	0.6	*
Mean epididymal volume (ml)	15.51	0.44	15.19	0.67	NS
Mean epididymal density (g/cm^3)	0.89	0.01	0.85	0.02	NS

N: Number; SE: Standard Error, ANOVA: Analysis of Variance, *: P<0.05; **: P<0.01; ***: P<0.001.

Nevertheless, the chest circumference, shoulders width, pelvis length, paired testes weight, mean testes length, testes diameter, mean testes volume, mean testes density, paired epididymal weight, and mean epididymal length differed significantly according to the ecotype of reared sheep (P<0.05). Indeed, at the age of 12 months, the live weight of local Djallonke sheep of North and South ecotypes of Benin varied between 20.41 and 21.76 kg while the head length, height at shoulder, scapulo-ischium length, scrotal length, scrotal circumference, mean epididymal volume and the mean epididymal density were similar among ecotypes and varied respectively between 18 and

18.42 cm; 55.96 and 53.33 cm; 60.85 and 60.38 cm; 14.31 and 13.87 cm; 23.26 and 21.08 cm; 15.51 and 15.19 ml and between 0.89 and 0.85 g/cm^3. Furthermore, the highest chest circumference (69.24 vs 73.29 cm), back width (15.78 vs 14 cm) and pelvis length (23.03 vs 16.8 cm) were recorded in the animals of North ecotype (P<0.05). similarly, paired testes weight, mean testes length, testes diameter, mean testes volume, mean testes density, paired epididymal weight, mean epididymal length, mean epididymal volume, and the mean epididymal density of local Djallonke sheep of North ecotypes of Benin were respectively of 300.86g, 6.91 cm, 4.82cm, 146.14 ml, 1.02 g/cm^3, 27.8 g and 20.1 cm to the respective values of 274.29g, 6.09 cm, 4.24 cm, 128.8 ml, 1.06 g/cm^3.

Relationships between Testicular and Body Morphometric Traits in Local Djallonke Sheep of South Ecotypes of Benin

The table 2 present the correlation between testicular and body morphometric traits in local Djallonke sheep of South ecotypes of Benin. It appears that live weight is strongly and positively associated with scrotal length, scrotal circumference, paired testes weight, mean testes length, testes diameter, mean testes volume, paired epididymal weight, mean epididymal length and mean epididymal volume (0.80≤ r ≤0.90; P<0.001). In the same way, Whither's height is strongly and positively associated with scrotal length, scrotal circumference, paired testes weight, mean testes length, testes diameter, mean testes volume, paired epididymal weight, mean epididymal length and mean epididymal volume (0.66≤ r ≤0.89; P<0.001). The scapulo-ischium length is however fairly and positively associated with scrotal length, scrotal circumference, paired testes weight, testes diameter, mean testes volume, paired epididymal weight, mean epididymal length and mean epididymal volume (0.66≤ r ≤0.89; P<0.01) but slightly and positively associated with mean testes length (r =0.51; P<0.05). Moreover, outwards mean testes length (r =0.67; P<0.001) which is strongly and positively associated with chest circumference; the scrotal length, scrotal circumference, paired testes weight, mean testes length, testes diameter, mean testes volume, paired epididymal weight, mean epididymal length and mean epididymal volume (0.52≤ r ≤0.63; P<0.001) is fairly and positively associated with chest circumference.

Relationships between Testicular and Body Morphometric Traits in Local Djallonke Sheep of North Ecotypes of Benin

The table 3 show the relationships between testicular and body morphometric traits in local Djallonke sheep of North ecotypes of Benin. It present that live weight is proportional to scrotal circumference, paired testes weight, mean testes length, testes diameter, mean testes volume, paired epididymal weight, mean epididymal length and mean epididymal volume (0.87≤ r ≤0.99; P<0.001); fairly and positively associated with scrotal length (r =0.66; P<0.01) and slightly and positively associated with mean testes density (r =0.54; P<0.05). Contrary, mean testes density (r =0.38; P<0.05) only is associated with scapulo-ischium length but slightly and positively. However, the chest circumference is fairly and positively associated with paired testes weight, paired epididymal weight and mean epididymal length (0.56≤ r ≤0.57; P<0.01) but slightly and positively associated with scrotal circumference, mean testes length, testes diameter, mean testes volume, mean testes volume, mean epididymal volume and mean epididymal density (0.39≤ r ≤0.54; P<0.05).

Table 2: Relationships between testicular and body morphometric traits in local Djallonke sheep of South ecotype of Benin.

Variables	LW	HW	SIL	CC	SL	SC	PTW	MTL	TD	MTV	MTD	PEW	MEL	MEV	MED
LW	1														
HW	0.89^{***}	1													
SIL	0.56^{**}	0.63^{**}	1												
CC	0.66^{***}	0.65^{**}	0.5^{*}	1											
SL	0.89^{***}	0.82^{***}	0.57^{**}	0.55^{**}	1										
SC	0.90^{***}	0.74^{***}	0.55^{**}	0.63^{**}	0.81^{***}	1									
PTW	0.809^{***}	0.68^{***}	0.54^{**}	0.52^{**}	0.79^{***}	0.91^{***}	1								
MTL	0.81^{***}	0.66^{***}	0.51^{*}	0.54^{**}	0.80^{***}	0.91^{***}	0.98^{***}	1							
TD	0.81^{***}	0.66^{***}	0.53^{**}	0.54^{**}	0.81^{***}	0.91^{***}	0.98^{***}	0.99^{***}	1						
MTV	0.81^{***}	0.66^{***}	0.52^{**}	0.55^{**}	0.80^{***}	0.91^{***}	0.98^{***}	1.00^{***}	0.99^{***}	1					
MTD	-0.07^{NS}	0.08^{NS}	0.07^{NS}	-0.14^{NS}	-0.17^{NS}	-0.08^{NS}	0.001^{NS}	-0.16^{NS}	-0.14^{NS}	-0.15^{NS}	1				
PEW	0.81^{***}	0.68^{***}	0.54^{**}	0.53^{**}	0.79^{***}	0.91^{***}	1.00^{***}	0.98^{***}	0.98^{***}	0.98^{***}	0.002^{NS}	1			
MEL	0.80^{***}	0.68^{***}	0.54^{**}	0.52^{**}	0.79^{***}	0.90^{***}	1.00^{***}	0.98^{***}	0.98^{***}	0.98^{***}	0.005^{NS}	1.00^{***}	1		
MEV	0.89^{***}	0.89^{***}	0.55^{**}	0.67^{***}	0.78^{***}	0.69^{***}	0.62^{**}	0.61^{**}	0.61^{**}	0.61^{**}	0.01^{NS}	0.62^{**}	0.62^{**}	1	
MED	-0.23^{NS}	-0.38^{NS}	-0.13^{NS}	-0.26^{NS}	-0.12^{NS}	0.06^{NS}	0.21^{NS}	0.22^{NS}	0.23^{NS}	0.22^{NS}	-0.13^{NS}	0.21^{NS}	0.21^{NS}	-0.60^{**}	1

LW: Live weight (kg), HW: Whither's height (cm), SIL: Scapulo-Ischium length (cm), CC: Chest Circumference (cm), SL: Scrotal length (cm), SC: Scrotal circumference (cm), PTW: Paired testes weight (g), MTL: Mean testes length (cm), TD: Testes diameter (cm), MTV: Mean testes volume (ml), MTD: Mean testes density (g/cm3), PEW: Paired epididymal weight (g), MEL: Mean epididymal length (cm), MEV: Mean epididymal volume (ml), MED: Mean epididymal density (g/cm3). NS: P>0.05, *: P<0.05, **: P<0.01, ***: P<0.001.

Table 3: Relationships between testicular and body morphometric traits in local Djallonke sheep of North ecotype of Benin.

Variables	LW	HW	SIL	CC	SL	SC	PTW	MTL	TD	MTV	MTD	PEW	MEL	MEV	MED
LW	1														
HW	0.84^{***}	1													
SIL	0.68^{**}	0.57^{**}	1												
CC	0.57^{**}	0.20^{NS}	0.24^{NS}	1											
SL	0.66^{**}	0.20^{NS}	0.10^{NS}	0.33^{NS}	1										
SC	0.97^{***}	0.28^{NS}	0.31^{NS}	0.54^{*}	0.61^{**}	1									
PTW	0.99^{***}	0.25^{NS}	0.27^{NS}	0.57^{**}	0.65^{**}	0.97^{***}	1								
MTL	0.97^{***}	0.23^{NS}	0.21^{NS}	0.52^{*}	0.68^{**}	0.94^{***}	0.97^{***}	1							
TD	0.97^{***}	0.23^{NS}	0.20^{NS}	0.49^{*}	0.69^{**}	0.94^{***}	0.97^{***}	0.99^{***}	1						
MTV	0.97^{***}	0.24^{NS}	0.21^{NS}	0.51^{*}	0.69^{**}	0.94^{***}	0.97^{***}	1.00^{***}	0.99^{***}	1					
MTD	0.54^{*}	0.22^{NS}	0.38^{*}	0.51^{*}	0.14^{NS}	0.57^{**}	0.55^{**}	0.36^{NS}	0.36^{NS}	0.36^{NS}	1				
PEW	0.99^{***}	0.26^{NS}	0.27^{NS}	0.57^{**}	0.65^{**}	0.97^{***}	1.00^{***}	0.97^{***}	0.97^{***}	0.97^{***}	0.55^{**}	1			
MEL	0.99^{***}	0.25^{NS}	0.27^{NS}	0.56^{**}	0.65^{**}	0.97^{***}	1.00^{***}	0.97^{***}	0.97^{***}	0.97^{***}	0.55^{**}	1.00^{***}	1		
MEV	0.87^{***}	0.19^{NS}	0.23^{NS}	0.39^{*}	0.68^{**}	0.83^{***}	0.88^{***}	0.90^{***}	0.90^{***}	0.90^{***}	0.31^{NS}	0.88^{***}	0.88^{***}	1	
MED	0.32^{NS}	0.17^{NS}	0.09^{NS}	0.43^{*}	0.02^{NS}	0.34^{NS}	0.29^{NS}	0.20^{NS}	0.20^{NS}	0.21^{NS}	0.47^{*}	0.29^{NS}	0.29^{NS}	-0.18^{NS}	1

LW: Live weight (kg), HW: Whither's height (cm), SIL: Scapulo-Ischium length (cm), CC: Chest Circumference (cm), SL: Scrotal length (cm), SC: Scrotal circumference (cm), PTW: Paired testes weight (g), MTL: Mean testes length (cm), TD: Testes diameter (cm), MTV: Mean testes volume (ml), MTD: Mean testes density (g/cm3), PEW: Paired epididymal weight (g), MEL: Mean epididymal length (cm), MEV: Mean epididymal volume (ml), MED: Mean epididymal density (g/cm3). NS: P>0.05, *: P<0.05, **: P<0.01, ***: P<0.001.

Discussion

Variation in Body and Testicular Morphometric Traits in Local Djallonke Sheep of North and South Ecotypes of Benin

Our results showed that birth weight were similar for the both ecotypes at 12 months old and vary between 20.41 and 21.76 kg. Several authors concluded, in contrast, that the genotype or the breeds of sheep reared under comparable conditions have frequently different age-type weight and average daily gains (Boly *et al.*, 2000; Gbangboche 2005a; Doko *et al.*, 2013). These authors linked it to several factors including the genetic type and natural selection (Lebbie and Ramsay, 1999; Gbangboche, 2005b; Youssao, 2008). This reality is highlighted by the results of our study which show that Djallonke Dwarf sheep of North ecotype were significantly heavier with fast growth rate than South ecotype. Poivey *et al.*, (1982) reported high heritability for weight at three months of age and suggest taking this into account in the selection of dwarf sheep. It is therefore proven that the crossbreeds Sahelian x West African dwarf sheep express best growth performances than pure Djallonke breed (Amégé, 1984) and could be perceived as an alternative of improvement of the profitability of sheep rearing (Gbangboché *et al.*, 2002). Thus, the crossing between Djallonke sheep of North ecotype x South ecotype can improve the growth performances of South ecotype of Djallonke sheep and preserve their resistance to illness and the identity of the Djallonke breed.

The weights obtained at the 12th month of age in the dwarf sheeps of North and South ecotype are lower than the value of 30kg obtained by Amégé (2004) for Vogan sheep at 7 months old and the live weight of 37.3kg reported for Lohi sheep of 9 months old by Lashari and Tasawar (2010). These confirm that the growth performances of the West African dwarf sheep reared in Benin have relatively very low growth performance and need improvement program, since body size is generally important parameters utilized in breeding soundness evaluation. Knowing the body weight of an animal is important for a number of reasons such as breeding, correct feeding, health matters, growth as well as classification.

In the current study, head length, height at whither, scapulo-ischium length, scrotal length, scrotal circumference, epididymal volume and the epididymal density were not affected by the ecotype of West African Dawarf sheep of Djallonke breed. This finding differ from the result of Ibrahim *et al.*, (2012) who observed that the scrotal circumference of Uda was higher than the one of Balami and Yankasa sheep breed. Similar reports of differences between breeds were also reported in goats (Raji *et al.*, 2008) and cattle (Abassi, 2011; Addass, 2011). These differences could be due to the effect of genotype or breed. Nevertheless, the scrotal circumference of Djallonke sheep of North ecotypes (23.26 ± 0.63) found herein was higher than the value of 21.50 ± 0.61, reported by Ahemen and Bitto (2007) for West African dwarf rams but similar with the value recorded in South ecotype. The scrotal circumference, the paired testes weight and the epididymal weight of the both ecotypes of Djallonke rams in this study was heavier than the values reported by Ahemen and Bitto (2007) for West African Dwarf rams. However, our values were overall lower than the results reported by Besta (2006) as testes weight (406 ± 40 g), testes volume (378 ± 44 mm), epididymal weight (33.85 ± 2.15 g) and epididymal volume (26.67 ± 3.42 mm) in Doper rams of South Africa. This differences confirm the effect of genotype, and shows the Djallonnke sheep of Benin is one of the smallest breed of indigenous sheep in West Africa.

Scrotal circumference is a good indicator of rams breeding ability. Schoenian (2011) had observed that ram lamb with scrotal circumference of less than 30 cm and adult rams with scrotal circumference of less than 32 cm are not recommended for breeding. According to Söderquist and Hultén (2006), the mean scrotal circumference in Gotlandie and Dorper mature rams were respectively 34.4 ± 2 cm, and 34.5 ± 0.9 cm. From Table 1, it was observed that paired testes weight, mean testes length, testes diameter, mean testes volume, mean testes density, paired epididymal weight, and mean epididymal length differed significantly according to the ecotype of reared sheep. These differences could be due to the effect of genotype or breed. Similar reports of differences between breeds were earlier reported in goats (Raji *et al.,* 2008) and cattle (Abassi, 2011; Addass, 2011).

Testicles weight, a soundness index of semen production ability and quality was found to depend on the ecotype in the current study. The results observed herein are similar to those found in other breeds of sheep in West Africa, but significantly higher than the values reported for West African Dwarf rams in Nigeria by Ahemen and Bitto (2007), and for Kajli rams in Pakistan by Siddiqui *et al.,* (2005). More so, it was reported that males with larger testes tend to sire daughters that reach puberty at an earlier age and ovulate more ova during each oestrus period (Söderquist and Hultén, 2006). Brito *et al.,* (2004) have reported that heavier testes produce more spermatozoa than the smaller testes in breeding animals. The significant higher testes weight of sheep Djallonke of North ecotype in this study would mean that those testes could contain more seminiferous tubule, interstitial endocrine cells and possibly more spermatozoa than the South ecotype. More so, the mean testes volume of sheep Djallonke of North ecotype was significantly ($p<0.05$) higher than that of the South one. The variation in the testes volume for the different breed observed in this study agrees with the report of Ibrahim (2012) in different strains of chicken. The superiority of sheep Djallonke of North ecotype which is believed to be the largest breed of sheep in Benin is an indication of higher sperm production potentials and a higher storage capacity.

Relationships between Testicular and Body Morphometric Traits

In this study, it appears that the live weight is very strongly associated with the testicular measurement of Djallonke sheep of both ecotype. The similar results were presented by Agga *et al.,* (2011). According to these author, body size and testicular measurements have been found to be important parameters for evaluating breeding soundness. Similarly, Karakus *et al.,* (2010) reported that body weight significantly influenced testes length and testes density, respectively. As a result of the beneficial attributes and high heritability estimates (0.4-0.7) of testicular size (Coulter and Foote, 1979), measurements would be useful selection criteria for improvement of flock. Salhab *et al.,* (2002), reported that the various testicular measurements were more correlated with body weight of growing lambs than age. Furthermore, Pochron and Wright (2002), showed the significant positive relationship between body size and testicles of animals in non-breeding season. Intraspecific variation in testis size (ejaculate investment) has been implicated as an important factor in male reproductive success because larger testes produce higher quality ejaculates (number of sperm, ejaculate volume and motility) and have higher rates of sperm production (Gomendio *et al.,* 1998). Thus males with larger testes are assumed to have higher reproductive success than males with small testes in species with sperm competition (Schulte- Hostedde *et al.,*).

Moreover, measuring scrotal circumference is particularly important examination of yearling bulls, and it is highly correlated with sperm production and semen quality Brito *et al.,* 2002. It has been shown that testicular diameter and along with scrotal circumference are excellent indicators of spermatogenic function, while body weight either alone or in combination with other variables, have been found to be related to semen volume (Marco-Jimenez *et al.,* 2005; Mekasha *et al.,* 2008; Elmaz *et al.,*). The positive association between scrotal circumference and body weight is an indication that improvement in both traits is possible through selection procedures, considering their high genetic correlations (Duguma *et al.,* 2002; Pourlis, 2011). This is an indication that genes that contributed to body weigth had an influence in the reproductive ability of rams. Scrotal circumference is a simple repeatable method of measurement of testicular size which is highly correlated with testicular weight, semen quality, and with fertility (Waldner *et al.,* 2010).

A significant and positive correlations exist between the testes weight and several morphometric traits. This finding is similar with the report obtained in goat (Bitto and Egbuinike, 2006), ram

(Ahemen and Bitto, 2007), chicken (Orlu and Egbunike, 2010; Ibrahim, 2012). Similarly, scrotal circumference has been shown to correlates ($p<0.05$, $p<0.01$) with epididymal weight, tunica albuginea, testes volume, and all epididymal segments. Similar observation was reported by Osinowo *et al.*, (1977), Tegegne *et al.*, (1992), Ugwu, Bitto and Okpale (2006). Overall, the correlation results indicate that the increase in one testicular traits lead to an increase in the other and vice versa. The good and positive correlations between testes weight, scrotal circumference and morphometric characteristics indicates the possibility of predicting organs weight, since testes weight is known to be very highly correlates with testicular sperm reserves (Ogwuegbu *et al.*, 1985) and males with larger testes tend to produce more sperm (Okwun *et al.*, 1996). Also, Keith *et al.*, (2009) suggested the use of scrotal size and testicular measurements to select for improved sperm production and breeding males.

Conclusion

The study revealed that chest circumference, back width, pelvis length, paired testes weight, mean testes length, testes diameter, mean testes volume, mean testes density, paired epididymal weight, mean epididymal length, mean epididymal volume and the mean epididymal density depend on the ecotype of reared Djallonke sheep with the best testicles size recorded in North ecotype.

In sheep of South ecotype, the live weight was strongly and positively associated with scrotal length, scrotal circumference, paired testes weight, mean testes length, testes diameter, mean testes volume, paired epididymal weight, mean epididymal length and mean epididymal volume; while in sheep of North ecotype, the live weight was proportional to scrotal circumference, paired testes weight, mean testes length, testes diameter, mean testes volume, paired epididymal weight, mean epididymal length and mean epididymal volume; fairly and positively associated with scrotal length and slightly and positively associated with mean testes density. Live weigth is a good indicator of testicle size. Therefore, improve one breeding conditions and live weigth will improve the other traits as a correlated response.

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