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Research Article

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Evaluation of Semen Collected From Slaughtered Iraqi Rams In the Breeding Season

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Abstract: Background: In contrast with ejaculate collection generally capturing a complete spectrum of spermatozoa at once at the time of peak collection, epididymal spermatozoa retrieved from the cauda epididymis of slaughtered rams represent a practical, low-cost, and invaluable resource to those seeking to assess sperm quality or preserve germplasm in situations where its conventional harvest is impractical. Although a few studies on epididymal sperm characteristics in matured indigenous Iraqi rams provided data on seasonal variation, a comprehensive evaluation or reference material of such sperm characteristics remain limited. Objectives: evaluate testicular size, epididymal sperm characteristics such as concentration, motility, viability, morphology, plasma membrane integrity and acrosome integrity of slaughtered Iraqi rams during the breeding season, to investigate correlations between with animal, testicular and sperm-quality parameters. Materials and Methods: This study was performed as descriptive study at University of Al-Qasim Green, Iraq; reproductive tracts for 50 sexually matured Iraqi rams were collected between April and July 2026. Slicing technique was used to recover epididymal spermatozoa from the cauda epididymis. Sperm concentration was measured using a spectrophotometer; sperm motility using a microscope; viability and morphology was performed using Eosin–Nigrosin staining; plasma membrane integrity (PMI) was analyzed using the hypo-osmotic swelling test (HOST); and acrosome integrity was assessed using Giemsa staining. Experimental testis was gonadal weight, gonadal length, gonadal width for each testis. Analysis was performed using SPSS -descriptive statistics, Pearson correlation -$P < 0.05$. Results: The rams had a mean age, body weight and body condition score (BCS) of 3.50 ± 1.11 years, 60.89 ± 8.53 kg and 3.40 ± 0.58, respectively. Mean (±SD) right and left testicular weights were 196.95 ± 18.20 g and 189.73 ± 17.26 g, respectively, mean epididymal sperm concentration was 590.50 ± 104.14 million/mL, and total and progressive motility were 79.06 ± 8.35% and 64.93 ± 8.71%, respectively. The sperm viability (%), normal morphology (%), HOST positive response (%) and intact acrosome (%) were found to be 82.00 ± 7.24%, 83.50 ± 6.62%, 81.00 ± 7.52% and 82.50 ± 6.85%, respectively. The left testis was correlated with sperm concentration ($r = 0.882$; $P < 0.001$) and total motility ($r = 0.929$; $P < 0.001$); the right testis was highly significantly correlated with sperm concentration ($r = 0.691$; $P < 0.001$), total motility ($r = 0.674$; $P < 0.001$), viability ($r = 0.360$; $P = 0.0103$), and normal morphology ($r = 0.550$; $P < 0.001$). Sperm concentration did not correlate significantly with age and body weight. Conclusion: The results show that the viability, motility, morphology and integrity of the epididymal spermatozoa recovered from slaughtered Iraqi rams in their breeding season appears to be satisfactory and the testicular biometric parameters (weight, length and width) of a testis are closely correlated with sperm quality, denoting testicular biometry to be a good adjunctive element for ram selection as genetic salvage or breeding soundness.

Keywords: Epididymal sperm; Iraqi rams; testicular biometry; sperm motility; hypo-osmotic swelling test; breeding season.

INTRODUCTION

Indigenous breeds such as the Awassi sheep play a significant role in meat, milk, and wool production in Iraq; thus, sheep production comprises one of the core sectors of livestock-based production systems in Iraq, owing to the survival, productivity and adaptive capacity of these animals under extreme environmental regions such as Iraq, where average annual precipitation is below 150 mm and ambient temperatures can reach as high as 65 °C in some areas. Given the disproportionately high contribution of the male to genetic progress within the flock, estimation of male reproductive potential is critical to the longterm maintenance and improvement of reproductive efficiency [Azawi, O. I., & Ismaeel, M. A. 2012]. Various studies reported distinct breeding and non-breeding periods in rams adapted to different latitudes even in subtropical Awassi breed sheep, and testicular size and semen characteristics are significantly affected by photoperiod and season, growth hormone dynamics, and functions as well as the testicular function depression due to high environmental temperature known as summer or heat-associated reproductive dysfunction [Azawi, O. I., & Ismaeel, M. A. 2012]. If the collection of ejaculate using artificial vagina or electroejaculation proves impractical, is unavailable or if the animal has already been slaughtered at the factory, spermatozoa can still be obtained directly from the cauda epididymis the end part of the epididymis the portion in which spermatozoa are finalised maturation and stored before to ejaculation [Safsaf, B. *et al*., 2015; Abu, A. H. *et al*., 2016]. This strategy offers a pragmatic method of salvaging genetic material from both valuable and unexpectedly lost males and assessing semen quality at slaughterhouses where many animals of known origin can be sampled with low marginal cost as cauda epididymal spermatozoa are functionally and structurally similar to those of ejaculated spermatozoa [Safsaf, B. *et al*., 2015; Abu, A. H. *et al*., 2016]. The

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biornetric measurements such as testicular weight, testicular length, and testicular width are strongly associated with spermatogenic potential and sperm output in the ram and other small ruminants, Similarly, the testicular size can be defined as the length, breadth, height, and volume of the testis, testicular biometry gives a direct idea regarding a hormonal output, and sexual maturity. In indigenous ram breeds and in other domestic ruminants, there are positive associations between testicular dimensions and sperm concentration, motility, and morphology [Hasani Al-Ameri, M. 2022; Atawalna, J. *et al*., 2022; Sarker, S. *et al*., 2012], and the relationships between testicular structure, vascularity, and semen quality have also been confirmed by the use of noninvasive tools, including ultrasonography and Doppler assessment of testicular blood flow [Sarker, S. *et al*., 2012; Kozłowska, N. *et al*., 2022]. A complete assessment of epididymal sperm quality is achieved with the use of several complementary laboratory techniques. The sperm concentration is estimated spectrophotometrically, motility is determined by direct examination under the microscope, and the viability and morphology are commonly assessed using the Eosin–Nigrosin supravital staining technique which differentiates live from dead spermatozoa on the basis of the permeability of the membranes to the dye [Safsaf, B. *et al*., 2015; Abu, A. H. *et al*., 2016]. The hypo-osmotic swelling test (HOST) evaluates functional integrity of the plasma membrane, the principle of the test is that, upon exposure to osmotic stress, spermatozoa with an intact and physiologically active membrane demonstrate characteristic coiling of the tail [Vasquez, J. *et al*., 2021]; while acrosomal status is usually assessed by means of Giemsa staining, which differentiates intact from disrupted acrosomes [Abecia, J. A. *et al*., 2020; Kozłowska, N. *et al*., 2022]. Considered together, these parameters offer a multidimensional sperm quality profile that is far more informative than any single measure considered in isolation. Although breed, geographic origin, nutritional status, and management system might affect the semen and testicular characteristics of rams, comparative information among different ram breeds such as the Ouled-Djellal, the Red Sokoto, the West African Dwarf, the Rasa Aragonesa, and several Portuguese native breeds highlight this variability [Safsaf, B. *et al*., 2015; Abu, A. H. *et al*., 2016; Atawalna, J. *et al*., 2022; Abecia, J. A. *et al*., 2020; Barbas, J. P. *et al*., 2023]. These inclusively demonstrate that, although producing ~34% of the national sheep population, very little is published reporting the sperm functional parameters of indigenous Iraqi sheep breeds such as the Awassi and other local rams, and even less from data specifically collected using epididymal sperm quality of slaughtered Iraqi rams during the natural breeding season, and indeed the relationships linking testicular biometry to sperm functional parameters remain uncharacterized in this special population [Azawi, O. I., & Ismaeel, M. A. 2012; Hasani Al-Ameri, M. 2022]. Thus, the current study was designed to investigate the correlations between animal characteristics, testicular measurements and epididymal sperm quality parameters including sperm concentration, motility, viability, morphology, plasma membrane integrity and acrosome integrity of epididymal sperm retrieved from slaughtered Iraqi rams during the breeding season.

MARTIAL AND METHOD

Study Design

This type of study was conducted as a descriptive study to determine the evaluation and quality of sperm isolated from the epididymis of Iraqi rams during the breeding season. The study was focus at the University of Al-Qasim Green, Iraq. total of 50 sexually mature Iraqi rams were included in the study. Sample collection was carried out during the period from April to July 2026. Reproductive tracts were collected after slaughter and transported to the laboratory for subsequent processing and evaluation of epididymal sperm characteristics.This study focused on the physical and microscopic characteristics of the epididymal sperm, overall and progressive motility, viability, and morphology.

Sample Collection

Reproductive tracts were collected from slaughtered Iraqi rams during the breeding season from April to July 2026. Following slaughter, the testes together with the attached epididymides were carefully collected from each ram and identified using a unique identification number corresponding to the individual animal. The collected reproductive tracts were transferred to the laboratory for further processing and epididymal sperm collection. Particular attention was given to the cauda epididymis as the primary site for sperm recovery.

Transportation and Handling of Samples

Firstly after collection, the reproductive tracts were watch with identified and placed in a clean, labeled container. The samples were transported to the laboratory in an ice box to minimize changes in

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sperm quality during transportation. Samples were maintained at approximately 25°C during handling and transportation. Time of sample collection and the time of arrival at the laboratory were recorded for each sample. Upon arrival at the laboratory, Testes and epididymides were examined and prepared for subsequent epididymal sperm collection.

Epididymal Sperm Collection

Epididymal spermatozoa collected from the cauda epididymis by the slicing technique. Cauda epididymis was carefully extract from the testis and placed in a sterile Petri dish containing 0.9% normal saline. Tissue was then gently sliced using a sterile blade to allow the spermatozoa stored within the epididymal tissue to be released into the saline solution. Resulting sperm suspension was gently mixed and transferred into a labeled sterile tube for evaluation of sperm characteristics.

Evaluation of Sperm Characteristics

Sperm Concentration

Sperm concentration was determined using a spectrophotometer. Epididymal sperm suspension was diluted at a ratio of 0.5 using 0.9% normal saline. Absorbance of the diluted sperm suspension was measured spectrophotometrically at wavelengths of **260 and 280 nm**. Obtained absorbance values were used for the estimation of sperm concentration according to the calibration procedure or equation adopted in the laboratory, Results were expressed as million spermatozoa/mL.

Sperm Motility

Sperm motility was evaluated using a light microscope. Small drop of the epididymal sperm suspension was placed on a clean glass slide and examined microscopically. Sperm motility was assessed based on the movement of spermatozoa, With percentages of total motile and progressively motile spermatozoa were estimated. Immotile spermatozoa were also recorded. Results were expressed as percentages (%).

Sperm Viability

Sperm viability was evaluated by Eosin–Nigrosin staining technique. Small aliquot epididymal sperm suspension mixed with Eosin–Nigrosin stain and a smear was prepared on a clean glass slide. Smear was allowed to dry and examined under a light microscope. Live spermatozoa remained unstained, whereas dead spermatozoa showed pink or reddish staining due to uptake of eosin. Percentage of live and dead spermatozoa was identity by count appropriate number of sperm cells, and the results were expressed as percentages (%).

Sperm Morphology

Sperm morphology was evaluated by the Eosin–Nigrosin staining technique. Small aliquot of the epididymal sperm suspension was mixed with Eosin–Nigrosin stain, With thin smear was prepared on a clean glass slide. Smear was examined under a light microscope to evaluate the morphological characteristics of spermatozoa. Spermatozoa were classified as morphologically normal or abnormal according to the appearance of the head, midpiece, and tail. Percentages of normal and abnormal spermatozoa were calculated. Different types of morphological abnormalities, including head, midpiece, With tail abnormalities, were also recorded and expressed as percentages.

Plasma Membrane Integrity

Functional integrity of the sperm plasma membrane evaluated BY the hypo-osmotic swelling test (HOST). Sperm suspension was incubated in a hypo-osmotic solution under controlled laboratory conditions. Incubation, the spermatozoa were examined by a light microscope. Spermatozoa with an intact and functionally active plasma membrane showed characteristic swelling and curling of the sperm tail, whereas spermatozoa with damaged membranes showed no such response. Percentage of spermatozoa exhibiting the characteristic HOST response was calculated as an indicator of plasma membrane integrity.

Acrosome Integrity

Acrosome integrity evaluated using Giemsa staining. Thin smear of the epididymal sperm suspension was prepared on a clean glass slide and allowed to dry. Smear was then stained with Giemsa stain and examined under a light microscope. Spermatozoa were evaluated according to the appearance and integrity of the acrosomal region of the sperm head. Spermatozoa with a normal and intact acrosome were distinguished from those showing acrosomal damage or abnormalities. Percentage of spermatozoa with intact and damaged acrosomes was recorded.

Testicular Measurements

Following collection of the reproductive tracts, Right and left testes were carefully separated from the surrounding tissues and epididymides. Each testis was weighed separately By a calibrated electronic balance, and the weight was recorded in

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grams (g). Testicular length and width were measured separately for the right and left testes by a Vernier caliper, and the measurements were recorded in centimeters (cm). Obtained measurements were recorded for each ram using the corresponding animal identification number.

Statistical Analysis

Data obtained from the study were organized and analyzed using the Statistical Package for the Social Sciences (SPSS). Descriptive statistics were used to summarize the studied variables and presented as mean ± standard deviation (SD), together with minimum and maximum values. Correlation analysis was used to assess relationships between selected animal and testicular characteristics and sperm quality parameters. level of statistical significance was set at $P < 0.05$.

RESULTS

General and Demographic Characteristics

Demographic characteristics of the studied Iraqi rams showed that the mean age of the animals was **3.50 ± 1.11 years**, with an age range of **2–5 years**. Mean body weight was **60.89 ± 8.53 kg**, ranging from **47.0 to 75.0 kg**, while the mean body condition score (BCS) was **3.40 ± 0.58**, with values ranging from **2.5 to 4.3**. Demographic characteristics are in **Table 3.1**.

Table 3.1. General and demographic characteristics of the studied Iraqi rams (n = 50)

Parameter	Mean ± SD	Minimum	Maximum
Age (years)	3.50 ± 1.11	2.0	5.0
Body weight (kg)	60.89 ± 8.53	47.0	75.0
BCS (1–5)	3.40 ± 0.58	2.5	4.3

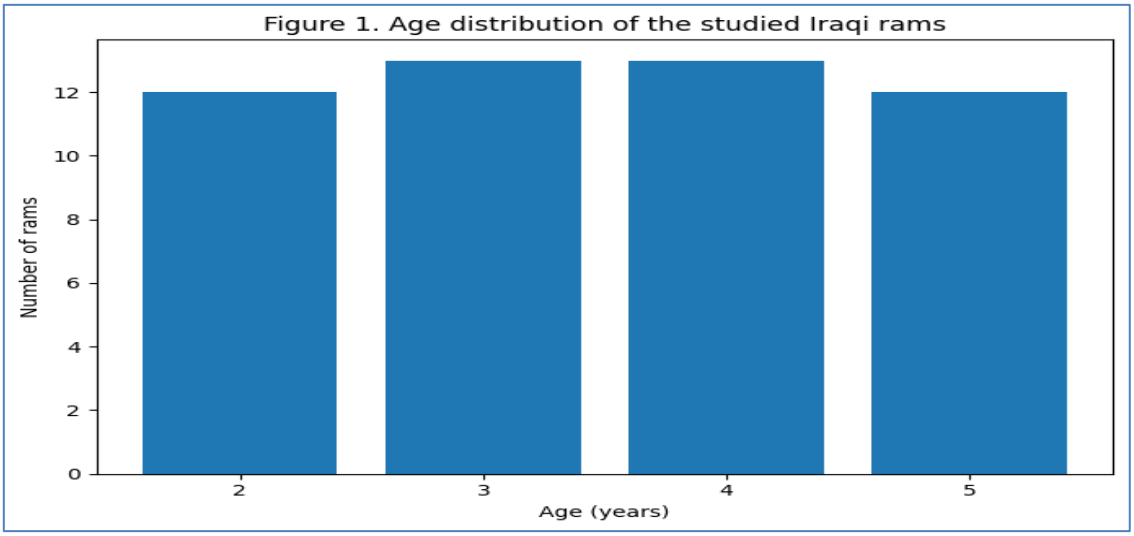

Figure 1. Age distribution of the studied Iraqi rams

Testicular Characteristics

Testicular measurements of the studied Iraqi rams showed that the mean weight of the right testis was **196.95 ± 18.20 g**, Compared with **189.73 ± 17.26 g** for the left testis. Mean length of the right and left testes was **8.90 ± 0.53 cm** and **8.72 ± 0.50 cm**, respectively. Regarding testicular width, the mean values were **5.61 ± 0.34 cm** for the right testis and **5.51 ± 0.34 cm** for the left testis. The minimum and maximum values for all testicular measurements are presented in **Table 3.2**.

Table 3.2. Testicular measurements of the studied Iraqi rams (n = 50)

Parameter	Mean ± SD	Minimum	Maximum
Right testis weight (g)	196.95 ± 18.20	166.60	229.50
Left testis weight (g)	189.73 ± 17.26	161.00	220.50
Right testis length (cm)	8.90 ± 0.53	8.03	9.79
Left testis length (cm)	8.72 ± 0.50	7.90	9.60
Right testis width (cm)	5.61 ± 0.34	5.05	6.19
Left testis width (cm)	5.51 ± 0.34	4.95	6.09

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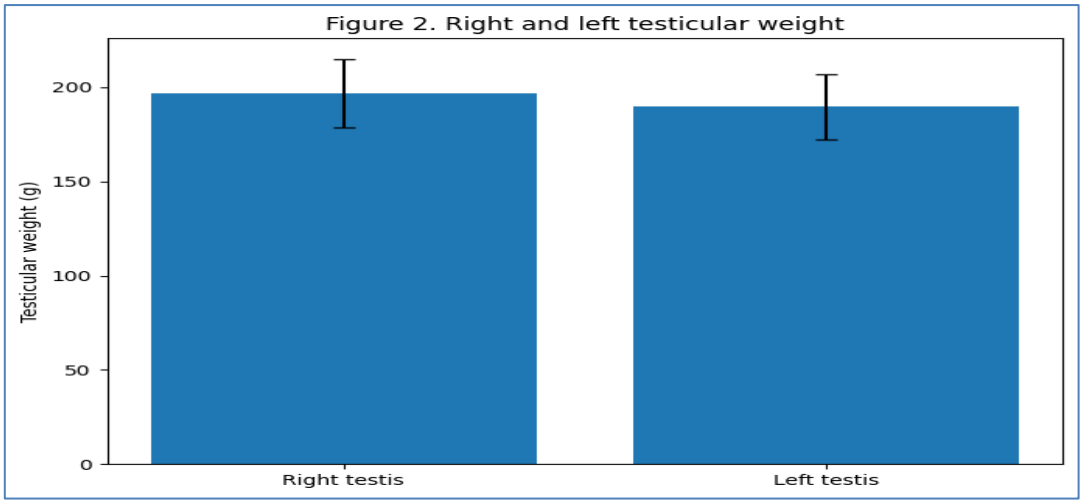

Figure 2. Right and left testicular weight

Characteristics of the Epididymal Sperm Samples

Characteristics of the epididymal sperm samples showed that mean volume of the recovered sperm suspension was **1.20 ± 0.23 mL**, ranging from **0.83 to 1.58 mL**. Mean sperm concentration **590.50 ± 104.14 million spermatozoa/mL**, with values ranging from **437.0 to 794.0 million spermatozoa/mL**. Findings are presented in **Table 3.3**.

Table 3.3. Characteristics of the epididymal sperm samples obtained from the studied Iraqi rams (n = 50)

Parameter	Mean ± SD	Minimum	Maximum
Extracted sample volume (mL)	1.20 ± 0.23	0.83	1.58
Sperm concentration (million/mL)	590.50 ± 104.14	437.0	794.0

Sperm Motility

Evaluation of sperm motility showed that the mean **total motility** was **79.06 ± 8.35%**, Where mean **progressive motility** was **64.93 ± 8.71%**. Mean percentage of **non-progressively motile spermatozoa** was **13.84 ± 3.47%**, I**mmotile spermatozoa** represented **20.94 ± 8.35%** total sperm population. Minimum and maximum values for sperm motility parameters are presented in **Table 3.4**.

Table 3.4. Sperm motility characteristics of epididymal sperm obtained from the studied Iraqi rams (n = 50)

Parameter	Mean ± SD	Minimum	Maximum
Total motility (%)	79.06 ± 8.35	66.9	93.6
Progressive motility (%)	64.93 ± 8.71	49.7	79.0
Non-progressive motility (%)	13.84 ± 3.47	8.8	19.9
Immotile sperm (%)	20.94 ± 8.35	6.4	33.1

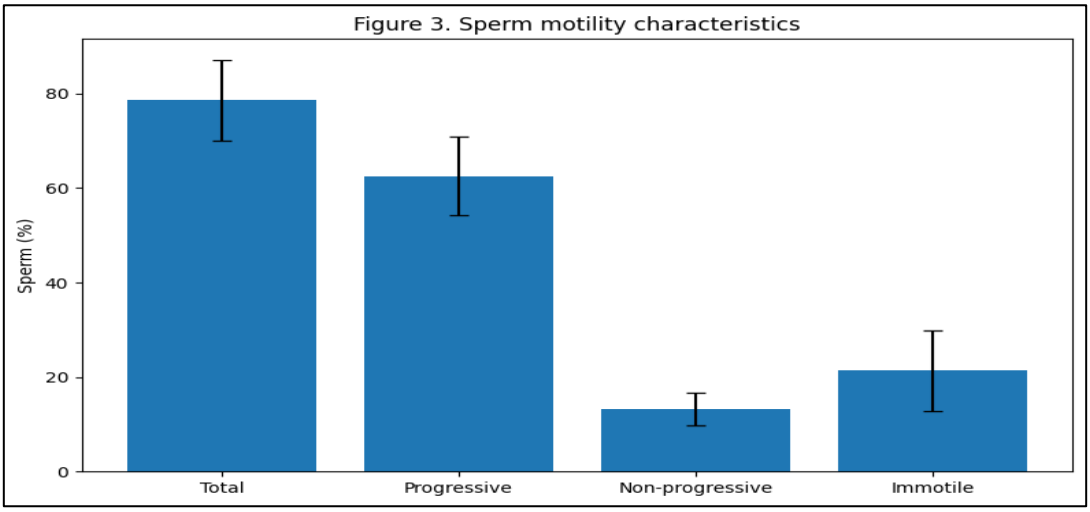

Figure 3. Sperm motility characteristics

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Sperm Viability

Assessment of sperm viability using the Eosin–Nigrosin staining technique showed that the mean percentage of **viable spermatozoa** was **82.00 ± 7.24%**, While the mean percentage of **dead spermatozoa** was **18.00 ± 7.24%**. Viability values ranged from **70.0 to 94.0%** for Viable spermatozoa and from **6.0 to 30.0%** for dead spermatozoa. Findings are presented in **Table 3.5**.

Table 3.5. Viability of epididymal spermatozoa obtained from the studied Iraqi rams using Eosin–Nigrosin staining (n = 50)

Parameter	Mean ± SD	Minimum	Maximum
Viable sperm (%)	82.00 ± 7.24	70.0	94.0
Dead sperm (%)	18.00 ± 7.24	6.0	30.0

Sperm Morphology

Evaluation of epididymal spermatozoa showed that the mean percentage of **normal spermatozoa** about **83.50 ± 6.62%**, A**bnormal spermatozoa** for **16.50 ± 6.62%**. Abnormalities include defects involving the head and midpiece, tail, Addition to cytoplasmic droplets , bent or coiled tails. Recorded values for normal ,abnormal sperm morphology present in **Table 3.6**.

Table 3.6. Morphological characteristics of epididymal spermatozoa obtained from the studied Iraqi rams (n = 50)

Morphological parameter	Mean ± SD	Minimum	Maximum
Normal morphology (%)	83.50 ± 6.62	73.2	94.0
Abnormal morphology (%)	16.50 ± 6.62	6.0	26.8
Head abnormalities (%)	5.99 ± 1.74	3.2	8.8
Midpiece abnormalities (%)	4.18 ± 0.88	2.2	5.0
Tail abnormalities (%)	6.88 ± 1.74	4.3	9.0
Proximal droplets (%)	2.99 ± 0.71	1.1	4.0
Distal droplets (%)	4.02 ± 0.71	2.1	5.0
Bent/coiled tail (%)	4.55 ± 1.74	2.2	7.0

Plasma Membrane Integrity

functional integrity of the sperm plasma membrane evaluat by the **hypo-osmotic swelling test (HOST)**. Mean percentage of spermatozoa showing a positive HOST response, indicating an intact and functionally active plasma membrane, **81.00 ± 7.52%**, whereas **19.00 ± 7.52%** of spermatozoa showed a negative response. Minimum and maximum values are present **Table 3.7**.

Table 3.7. Plasma membrane integrity of epididymal spermatozoa evaluated by the hypo-osmotic swelling test (HOST) (n = 50)

Parameter	Mean ± SD	Minimum	Maximum
Positive HOST response (%)	81.00 ± 7.52	68.0	94.0
Negative HOST response (%)	19.00 ± 7.52	6.0	32.0

Acrosome Integrity

Evaluation of acrosome integrity using **Giemsa staining** showed that mean percentage of spermatozoa with an **intact acrosome** was **82.50 ± 6.85%**, Mean mean percentage of spermatozoa , **acrosomal damage** was **17.50 ± 6.85%**. Recorded minimum and maximum values are present in **Table 3.8**.

Table 3.8. Acrosome integrity of epididymal spermatozoa evaluated using Giemsa staining (n = 50)

Parameter	Mean ± SD	Minimum	Maximum
Intact acrosome (%)	**82.50 ± 6.85**	**70.0**	**94.0**
Damaged acrosome (%)	**17.50 ± 6.85**	**6.0**	**30.0**

Correlation Analysis

Correlation analysis perform to relationships between animal characteristics, and testicular measurements, epididymal sperm quality parameters. Analysis included age, body weight, and testicular weight, testicular length and width, sperm concentration, motility, viability, and morphology. statistical was significance show in Table 3.9.

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Table 3.9. Correlations between animal characteristics, testicular measurements, and epididymal sperm quality parameters

Variable 1	Variable 2	Pearson r	P-value	Interpretation
Age	Sperm concentration	0.090	0.5348	Not significant
Body weight	Sperm concentration	0.218	0.1275	Not significant
Right testis weight	Sperm concentration	0.691	<0.001	Highly significant
Right testis weight	Total motility	0.674	<0.001	Highly significant
Right testis length	Viability	0.360	0.0103	Significant
Right testis width	Normal morphology	0.550	<0.001	Highly significant

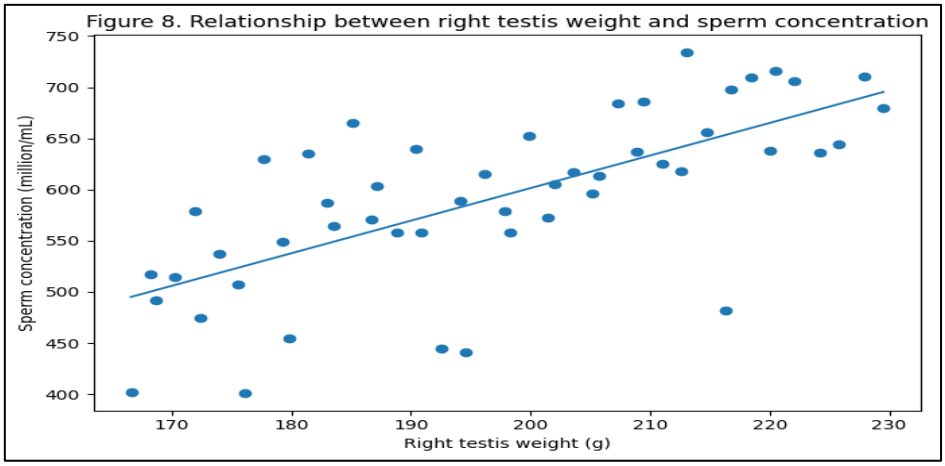

Figure 4. Relationship between right testis weight and sperm concentration

DISCUSSION

The rams evaluated in the current study were at the prime age for breeding (mean 3.50 ± 1.11 years) and stored a body condition score at or near the threshold deemed ideal for breeding soundness in rams, adhered to the general rule that rams should enter the breeding season with sufficient body reserves to not impair spermatogenesis or libido without impeding mobility or general health (Hafez and Hafez 2000). The demographic profile described is similar to that reported in other indigenous ram populations that have been examined in post-mortem for the purposes of genetic salvage in which mature sexually active males in good body condition had been specifically targeted for the recovery of epididymal sperm [Azawi, O. I., & Ismaeel, M. A. 2012; Hasani Al-Ameri, M. 2022].

Bilaterally, the mean right testicular weight (196.95 ± 18.20 g) was greater than left testicular weight (189.73 ± 17.26 g) and a similar right-over-left asymmetry for testicular length and testicular width (each P 80% viability) in the Ouled-Djellal study (82.15 ± 1.48%) [Vasquez, J. *et al*., 2013] and comparable or at least as high as pre-storage motility and viability reported for epididymal sperm retrieved from Red Sokoto bucks [Abu, A. H. *et al*., 2016], suggesting that the sperm recovery and handling protocol in this study was effective in preserving epididymal sperm viability without active cold-chain transport. The percentage of morphologically normal spermatozoa (83.50 ± 6.62%) and associated abnormality rate (16.50 ± 6.62%) for cauda epididymal spermatozoa were similar to the abnormal morphology reported for cauda epididymal spermatozoa of Ghanaian West African Dwarf rams (16.33 ± 7.9%) [Abecia, J. A. *et al*., 2020] in spite of the large differences in testicular size between the two ram breeds, suggesting that the proportion of morphologically normal spermatozoa reaching the cauda epididymis may be conserved across ram populations once puberty and full spermatogenic maturity has been reached. In comparison, the abnormal morphology detected for fresh ejaculated semen from Portuguese native breeds was lower than that noted here (10.1 ± 0.1%) [Kozłowska, N. *et al*., 2022]; since epididymal sperm samples, particularly those from which sperm were recovered immediately after slaughter, may contain a somewhat greater smeared percentage of immature or degenerating forms [including cytoplasmic droplets; Minervini *et al*. (21)], which normally would be expelled during ejaculation and through the course of the female tract, similar abnormalities were the predominant types of head, midpiece, tail, and droplet-associated defects noted in the present study. This proportion of spermatozoa displaying a positive hypo-osmotic

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swelling response (81.00 ± 7.52%) is also what one would expect for functionally competent epididymal ram spermatozoa when a hypo-osmotic solution and incubation protocol is properly optimized, as previously established for epididymal ram sperm (Vásquez *et al*., 2021). [Barbas, J. P. *et al*., 2023]. As HOST reactivity necessitates an intact, physiologically active plasma membrane functioning in a manner that permits maintenance of osmotic homeostasis, the high concordance between the HOST-positive proportion and the independently assessed viability and acrosome-intact proportions (82.00% and 82.50%, respectively) in the present study provides mutual corroborating evidence that the majority of recovered spermatozoa possessed functional membrane and acrosomal integrity at the time of assessment [Vasquez, J. *et al*., 2021; Abecia, J. A. *et al*., 2020]. The correlation analysis provides further biological insight into the determinants of epididymal sperm quality in this population. The highly significant positive correlations between right testicular weight and both sperm concentration ($r = 0.691$, $P < 0.001$) and total motility ($r = 0.674$, $P < 0.001$) are consistent with the well-established relationship between testicular mass, seminiferous epithelium volume, and daily sperm production reported in rams and other domestic ruminants. Similarly, the significant correlation between right testicular length and sperm viability ($r = 0.360$, $P = 0.0103$), and the highly significant correlation between right testicular width and normal sperm morphology ($r = 0.550$, $P < 0.001$), align with reports that testicular morphometric parameters are strongly and positively correlated with sperm reserves and sperm quality traits in rams, with correlation coefficients of comparable or greater magnitude reported in West African Dwarf rams ($r = 0.75$–0.94) [Atawalna, J. *et al*., 2022] and with the demonstrated association between testicular ultrasonographic and biometric measures and semen quality in indigenous ram breeds [Sarker, S. *et al*., 2012]. Assessment of testicular vascularity by Doppler ultrasonography has likewise been linked to sperm quality traits in rams across different reproductive periods, further supporting the biological plausibility of a testicular size–function relationship in this species [Kozłowska, N. *et al*., 2022]. In contrast, the absence of a significant correlation between age or body weight and sperm concentration ($r = 0.090$, $P = 0.535$ and $r = 0.218$, $P = 0.128$, respectively) suggests that, once sexual maturity has been attained within the 2–5-year age range studied here, chronological age and overall body mass are less directly predictive of sperm output than testicular size itself. This finding is compatible with reports that, beyond puberty, sperm characteristics of mature rams tend to remain relatively stable with advancing age, with testicular dimensions providing a more direct anatomical correlate of spermatogenic capacity than age or body

CONCLUSION

Epididymal spermatozoa recovered from the cauda epididymis of slaughtered Iraqi rams during the breeding season exhibited favorable sperm concentration, motility, viability, morphology, plasma membrane integrity, and acrosome integrity, indicating that post-mortem epididymal sperm recovery is a viable approach for evaluating and salvaging genetic material from breeding-age Iraqi rams during this period. Testicular weight, length, and width, particularly of the right testis, were significantly and positively correlated with sperm concentration, motility, viability, and normal morphology, whereas age and body weight showed no significant association with sperm concentration within the age range studied. These findings indicate that testicular biometric parameters, rather than chronological age or body weight, are the more informative predictors of epididymal sperm quality in mature Iraqi rams.

Based on these results, routine recording of testicular weight, length, and width is recommended as a simple, low-cost ancillary tool alongside epididymal sperm evaluation when assessing rams for breeding soundness or for genetic salvage following unplanned slaughter or death. Further studies incorporating larger and more geographically diverse samples of Iraqi rams, comparison between the breeding and non-breeding seasons, and the inclusion of hormonal and oxidative stress biomarkers are recommended to confirm and extend these findings.

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