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Impact of Housing Management Systems on Seminal Characteristics and Semen Freezability in Sirohi Bucks

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Abstract
This study was conducted to determine the effect of the management system (semi- intensive and intensive) on Seminal Characteristics and semen freezability in Sirohi bucks. A total of 6 Sirohi bucks were randomly allotted into two groups, viz., Group 1 (semi-intensive system, 3 bucks) and Group 2 (intensive system, 3 bucks). The results showed that in the fresh semen the ejaculate volume and mass motility were significantly ($p<0.05$) higher in Group I (0.88±0.03 ml, 4.69±0.08) compared to Group II (0.73±0.04 ml, 4.39±0.11) respectively. The sperm concentration, total sperm output per ejaculate, initial progressive motility, sperm livability, acrosomal integrity and plasma membrane integrity were found to be significantly higher ($p<0.05$) in Group 1 compared to Group 2. The enzyme leakage (AST and ALT) level were found to be significantly higher ($p<0.05$) in Group 2 compare to Group 1. Similar patterns were also seen in post-thaw seminal parameters too. Based on the findings of the study, it was concluded that the housing plays a crucial role in determining the seminal parameters. The value for different parameters of superior semen was recorded to be highest during semi-intensive system as compare to intensive system.

Key words: Sirohi, freezability, AST, ALT, acrosomal integrity.

1. Introduction

Goats (*Capra hircus*), possessing a chromosomal count of 60, are a source of meat, milk, skin, and wool, and are significant domestic farm animals globally (Onakpa *et al.,* 2010). Goat husbandry sustains the livelihoods of around 35 million families in India (Yadav *et al.,* 2020). They are aptly referred to as the "poor man's cow". The goat population in the nation rose by 10.1% from the previous census in 2012, reaching 148.89 million in 2019. Goat is now considered as the most promising livestock species for commercial meat (chevon) production second only to the poultry in the country. Sirohi being the most common breed of Rajasthan is typically found in dry and semi-arid area. The majority of Sirohi goats have medium-sized, flat, leaf-like falling ears and are wattled. Synonyms for this breed are Parbatsari, Devgarhi, and Ajmeri, and it is primarily raised for milk and meat. A number of obstacles are experienced by the farmers which mainly include the absence of sufficient breeding stock and the availability of high-quality feed and fodder. It is vital to include outstanding genetics into children in order to boost goats' potential for production, which is plainly attainable when exceptional sires are chosen. Goats' genetic composition can be enhanced by avoiding mating with buck that generates poor-quality semen. Management system plays a crucial role in enhancing the seminal quality. Although information is available on the semen characteristics of several goat breeds but no information is available on management system on freezability in Sirohi bucks.

2. Materials and Methods

2.1. Study Areas

The study was conducted in the Deep Frozen Semen Laboratory of Department of Veterinary Gynaecology and Obstetrics, College of Veterinary Sciences & Animal Husbandry, A.N.D.U.A.T, Kumarganj, Ayodhya, Uttar Pradesh, India.

2.2. Experimental Animals and Data Collection

A group of Six (Sirohi) healthy adult Goat bucks aged 3-4 years, with body weight 50-60 kg, were used as experimental animals. The bucks were grouped randomly into two groups and each group having three animals, Group 1 semi-intensive housing system and Group 2 intensive housing system. These animals are properly dewormed and vaccinated routinely. Regularly 4 hours of grazing were allowed to the animals in Group 1 while the animals in Group 2 were fed in stall feeding only.

2.3. Semen Collection and Evaluation

Semen was collected twice a week using an artificial vagina at a temperature of 42°C, during two seasons: autumn (September-November) and winter (December-February). A total of 288 semen samples (144 from each group) were evaluated for fresh and post-thaw semen parameters. The semen samples were immediately evaluated for colour, volume, and concentration upon collection. The semen volume was quantified utilizing a graduated collecting tube, measured in millilitres (ml). The sperm concentration of all samples was measured utilizing an Accucell photometer (IMV, France).

Total concentration/ Total sperm output is calculated by the formula

Tc/TSO = Concentration per ml (million) × Volume of ejaculation (ml)

2.4. Statistical Analysis

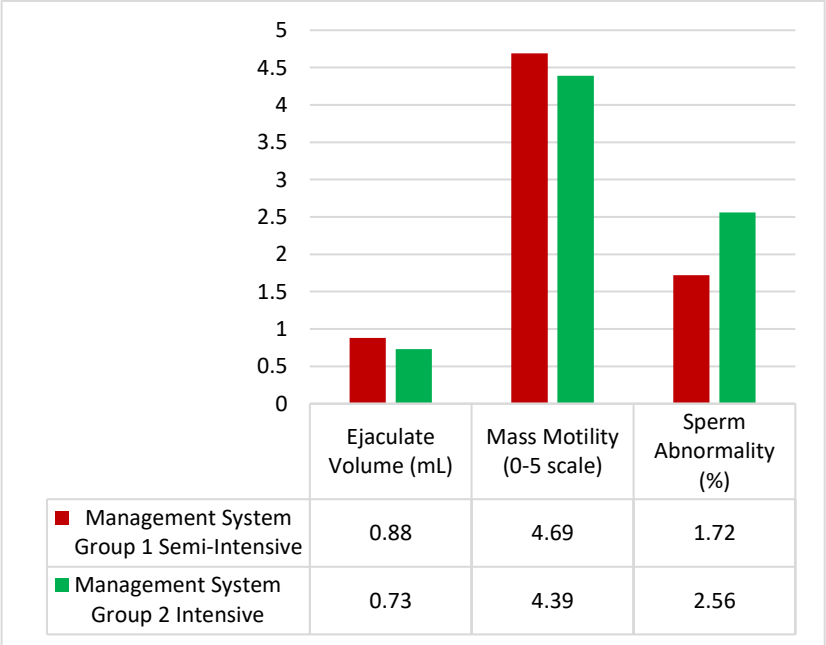
The data were analyzed by using paired t-test via SPSS and presented as the mean ± standard error of the mean (S.E.M). Duncan's multiple range test was conducted to identify significant differences among the mean values.

3. Results and Discussion

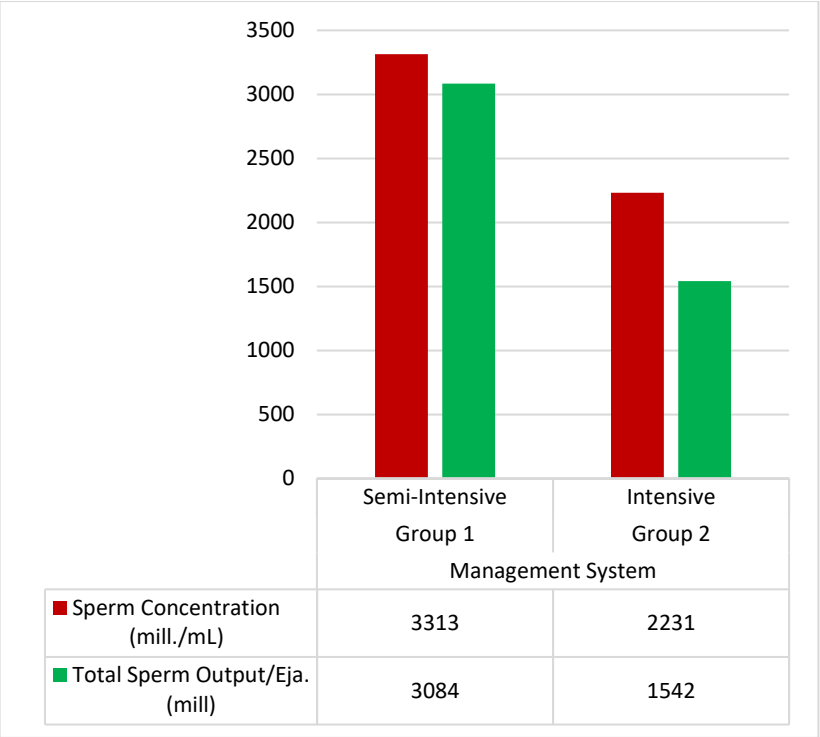
3.1. Fresh Seminal Parameters

Parameters	Management System		p-value	t-value
	Group 1 Semi-Intensive	Group 2 Intensive		
Ejaculate Volume (mL)	0.88 ± 0.03[a]	0.73 ± 0.04[b]	0.0011	3.397
Mass Motility (0-5 scale)	4.69 ± 0.08 [a]	4.39 ± 0.11[b]	0.0307	2.205
Sperm Concentration(mill./mL)	3313.00 ± 63.57 [a]	2231.00 ± 78.57[b]	0.0001	10.71
Total Sperm Output/Eja. (mill)	3084.00 ± 128.20 [a]	1542.00 ± 46.63[b]	0.0001	11.30
Initial Progressive Motility (%)	84.86 ± 0.38 [a]	81.61 ± 0.42 [b]	0.0001	5.733
Sperm Livability (%)	90.42 ± -0.40 [a]	86.75 ± 0.47 [b]	0.0001	5.969
Acrosomal Integrity (%)	92.75 ± 0.40 [a]	88.72 ± 0.50 [b]	0.0001	6.331
Sperm Abnormality (%)	1.72 ± 0.12 [b]	2.56 ± 0.20 [a]	0.0009	3.483
Plasma Membrane Integrity (%)	73.89 ± 0.31 [a]	70.61± 0.31[b]	0.0001	7.478
AST (U/L)	52.44 ± 0.58 [b]	63.47 ± 0.90 [a]	0.0001	10.30
ALT (U/L)	27.61 ± 0.59 [b]	35.69 ± 0.44[a]	0.0001	11.00

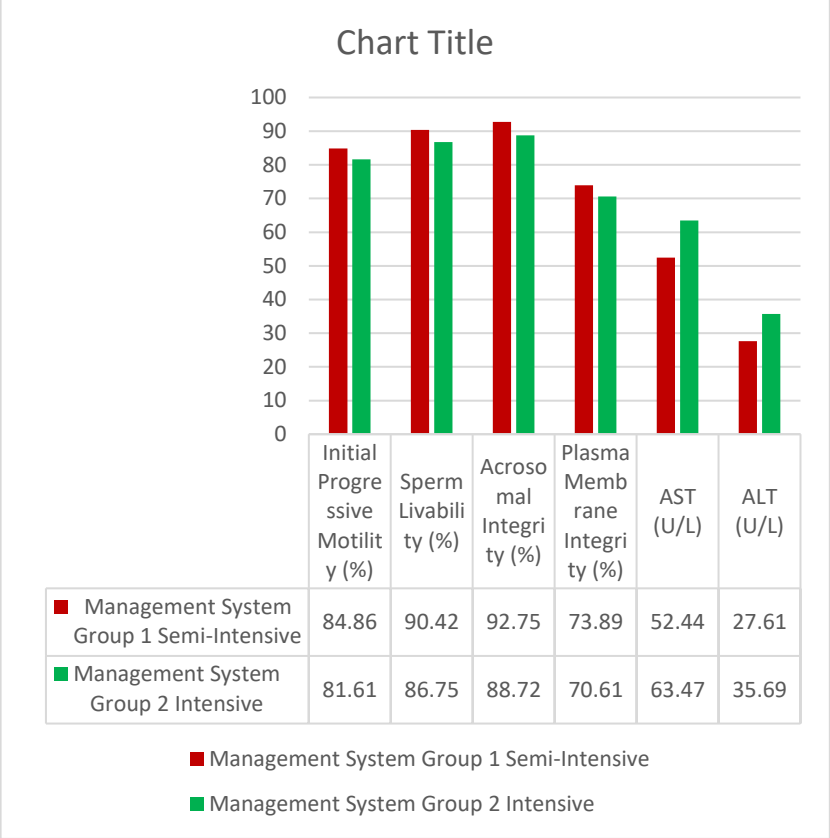
Means with different superscripts differ significantly (p<0.05) between groups.



Graph 1: Variations in ejaculated volume, mass motility and sperm abnormality in different housing system



Graph 2: Variations in sperm concentration and total sperm output in different housing system



Graph 3: Variations in Initial progressive motility, sperm livability, acrosomal integrity, plasma membrane integrity, ALT and AST in different housing systems

The means along with their standard errors and statistical significance of different seminal parameters in fresh semen of Sirohi bucks are presented in Table-1. The least square means of seminal attributes of both groups (Group 1: Semi-intensive and Group 2: Intensive) indicated that management system significantly influenced most semen quality parameters. The ejaculate volume was significantly ($p<0.05$) higher in Group 1 (0.88±0.03 ml) compared to Group 2 (0.73±0.04 ml). Similar

observations were reported by Leboeuf *et al.* (2000), who noted that improved management and exercise positively influence semen output in bucks. The mass motility was also significantly higher ($p<0.05$) in semi-intensive bucks (4.69±0.08) compared to intensive bucks (4.39±0.11). Comparable results were documented by Karagiannidis *et al.* (2000), who observed better motility in goats maintained under less confined systems.

The sperm concentration and total sperm output per ejaculate were significantly ($p<0.05$) higher in Group 1 (3313.00±63.57 mill/mL and 3084.00±128.20 million, respectively) than in Group 2 (2231.00±78.57 mill/mL and 1542.00±46.63 million). These findings are in agreement with Delgadillo *et al.* (1992), who reported that management conditions and environmental factors influence spermatogenic activity and semen production in bucks. Similarly, Summermatter (1993) reported higher sperm production in goats maintained under semi-intensive management compared to confined intensive systems. The superior ejaculate volume and concentration in Group 1 are consistent with Kumar *et al.* (2016), who reported that Jakhrana bucks reared under semi-intensive systems exhibited enhanced seminal profiles compared to stall-fed counterparts. The primary driver for this is likely testicular thermoregulation. As noted by Brito *et al.* (2004), scrotal temperature is a critical determinant of sperm output; the increased physical activity and exercise associated with grazing facilitate blood flow and heat dissipation through the pampiniform plexus. In contrast, the sedentary nature of intensive systems may lead to localized heat stress, which arrests spermatogenesis and leads to the reduced concentration observed in Group 2.

Initial progressive motility and sperm livability were significantly higher ($p<0.05$) in Group 1 (84.86±0.38% and 90.42±0.40%) compared to Group 2 (81.61±0.42% and 86.75±0.47%) respectively. The significantly higher livability and membrane integrity in Group 1 suggest a lower state of oxidative stress. This is likely due to the nutritional diversity found in semi-intensive systems. Bielli et al. (1999) observed that access to fresh forage provides exogenous antioxidants (Vitamin E, Beta-carotene, and Selenium) that are often depleted in stored concentrate diets. These antioxidants protect the polyunsaturated fatty acid-rich sperm membranes from lipid peroxidation. The present findings are consistent with Ahmad and Noakes (1996), who reported that better environmental and nutritional conditions improve sperm motility and viability. Similar observations were also reported by Tekin *et al.* (2016) in Angora bucks maintained under improved management practices.

Acrosomal integrity and plasma membrane integrity were significantly higher ($p<0.05$) in semi-intensive bucks (92.75±0.40% and 73.89±0.31%) compared to intensive bucks (88.72±0.50% and 70.61±0.31%) respectively. These findings suggest improved functional integrity of spermatozoa under semi-intensive management. Salamon and Maxwell (2000) reported that stress and poor management adversely affect sperm membrane stability and acrosomal structure. Similarly, Purdy (2006) noted that improved management conditions enhance structural integrity and fertilizing ability of spermatozoa in goats. The percentage of sperm abnormalities was significantly higher ($p<0.05$) in intensively managed bucks (2.56±0.20%) compared to semi-intensive bucks (1.72±0.12%), indicating compromised spermatogenesis under intensive conditions. Similar findings were reported by Verma (2022), who observed increased sperm abnormalities in bulls exposed to stressful management conditions. The significantly higher sperm abnormalities in Group 2 (2.56 ± 0.20) align with findings by Mazlishah *et al.* (2024), who linked confined housing to increased reactive oxygen species (ROS) production, which impairs morphological development during the epididymal transit.

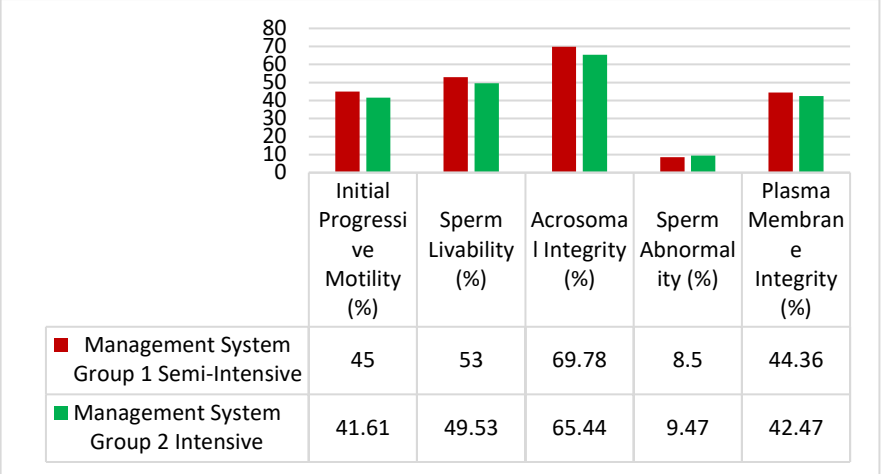
The biochemical analysis revealed significantly higher AST and ALT levels ($p<0.001$) in Group 2 (63.47±0.90 U/L and 35.69±0.44 U/L) compared to Group 1 (52.44±0.58 U/L and 27.61±0.59 U/L) respectively, indicating greater cellular damage and membrane leakage in intensively managed animals. Pesch *et al.* (2006) and Habeeb *et al.* (2024) established that AST and ALT are primarily intracellular enzymes; their presence in seminal plasma is a direct indicator of increased membrane permeability or cell death. Elevated seminal enzyme activity associated with reduced sperm quality was also reported by Purdy (2006) and Verma (2022) in goat semen studies.

3.2. Post-thaw Seminal Parameters

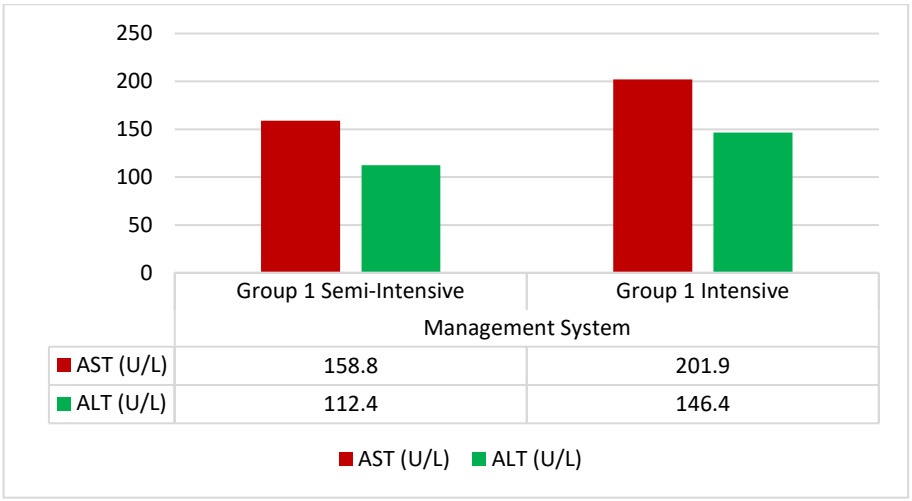
POST THAW POOL

Parameters	**Management System**		**P-Value**	**T-Value**
	Group 1 Semi-Intensive	**Group 2 Intensive**		
Initial Progressive Motility (%)	45.00 ± 0.46[a]	41.61 ± 0.42[b]	0.0001	5.487
Sperm Livability (%)	53.00 ± 0.47[a]	49.53 ± 0.45[b]	0.0001	5.379
Acrosomal Integrity (%)	69.78 ± 0.39[a]	65.44 ± 0.46[b]	0.0001	7.179
Sperm Abnormality (%)	8.50 ± 0.19[b]	9.47 ± 0.25[a]	0.0028	3.099
Plasma Membrane Integrity (%)	44.36 ± 0.39[a]	42.47 ± 0.25[b]	0.0001	4.071
AST (U/L)	158.80± 3.47[b]	201.90± 2.24[a]	0.0001	10.45
ALT (U/L)	112.40± 0.97[b]	146.40± 1.95[a]	0.0001	15.57

Means with different superscripts differ significantly (p<0.05) between groups.



Graph 4: Variations in Initial progressive motility, sperm livability, acrosomal integrity, sperm abnormality and plasma membrane integrity in different housing systems



Graph 5: Variations in enzyme leakage (ALT and AST) in different housing systems

The means along with their standard errors and statistical significance of different seminal parameters in post-thaw semen of Sirohi bucks are presented in Table-2. The least square means of seminal attributes of both groups (Group 1: Semi-intensive and Group 2: Intensive) indicated that management system significantly influenced most semen quality parameters. The mean initial progressive motility was significantly ($p<0.05$) higher in bucks maintained under semi-intensive system (45.00 ± 0.46%) compared to intensive system (41.61 ± 0.42%), with a t-value of 5.487. This indicates better cryosurvival of spermatozoa under semi-intensive management. Improved motility under semi-intensive conditions may be attributed to better exercise, reduced stress, and natural grazing, which positively influence spermatogenesis and seminal plasma composition. The present findings are in agreement with Dorado *et al*. (2010), who reported better post-thaw motility in goats maintained under favourable management conditions. Similar observations were also reported by Kumar *et al.* (2016) in Jakhrana bucks, where management and environmental factors significantly influenced sperm motility. However, slightly higher values than the present findings were reported by Sharma and Sood (2021) in Gaddi and Chegu bucks under semi-intensive system, suggesting breed and climatic variations may also contribute to differences in motility.

Sperm livability was significantly ($p<0.05$) higher in the semi-intensive group (53.00 ± 0.47%) compared to the intensive group (49.53 ± 0.45%), with a t-value of 5.379. Higher livability indicates better membrane stability and reduced cryo-damage during freezing and thawing. Intensive housing conditions may predispose animals to thermal and management stress, leading to increased oxidative damage and reduced sperm survival. These findings corroborate the reports of Memon (2012), who observed that management and environmental stress significantly affected sperm viability in bucks. Similar trends were also documented by Kumar *et al.* (2016) in indigenous goat breeds.

Acrosomal integrity was significantly ($p<0.05$) higher in the semi-intensive group (69.78 ± 0.39%) than in the intensive group (65.44 ± 0.46%), with a t-value of 7.179. Since the acrosome plays a critical role in fertilization through enzyme release and zona pellucida penetration, higher acrosomal integrity reflects superior fertilizing potential. The present results are consistent with earlier findings of Thakur *et al.* (2014), who reported higher acrosomal integrity in bucks maintained under semi-intensive systems. Kumar *et al.* (2016) also emphasized that improved management practices contribute to better acrosomal preservation during cryopreservation. Sperm abnormalities were significantly ($p<0.05$) lower in the semi-intensive group (8.50 ± 0.19%) compared to the intensive group (9.47 ± 0.25%), with a t-value of 3.099. Increased abnormalities in the intensive system may be due to stress-induced impairment of spermatogenesis. Management-related stress has been associated with increased morphological defects in spermatozoa. These findings are supported by the work of Bielli *et al.* (1999), who observed higher morphological abnormalities under intensive rearing conditions. Similar results were reported in goat bucks exposed to environmental stressors affecting semen quality.

Plasma membrane integrity (HOST response) was significantly ($p<0.05$) higher in the semi-intensive group (44.36 ± 0.39%) than in the intensive group (42.47 ± 0.25%), with a t-value of 4.071. The plasma membrane is the primary site of cryoinjury (Ugur *et al*., 2019). The integrity of the sperm plasma membrane is essential for maintaining motility, metabolic activity, and fertilizing ability. Improved membrane integrity under semi-intensive management suggests better physiological adaptability and reduced oxidative stress. Comparable findings were reported by Kumar *et al.* (2016), who observed significant variation in HOST response due to management and seasonal influences in Jakhrana bucks.

The levels of AST and ALT were significantly ($p<0.05$) higher in the intensive group (201.90 ± 2.24 U/L and 146.40 ± 1.95 U/L, respectively) compared to the semi-intensive group (158.80 ± 3.47 U/L and 112.40 ± 0.97 U/L), with t-values of 10.45 and 15.57, respectively. Elevated AST and ALT levels in seminal plasma are indicative of increased cellular damage and membrane leakage during cryopreservation. The higher enzyme activity observed in intensively managed bucks suggests greater cryo-injury and compromised membrane stability. Similar associations between elevated transaminase levels and reduced semen quality have been reported by Habeeb *et al.* (2024) and other researchers working on caprine semen cryopreservation. Cryopreservation induces an overproduction of Reactive Oxygen Species (ROS), leading to oxidative stress and lipid peroxidation (LPO) of the polyunsaturated fatty acid-rich sperm membranes (Ayad *et al*., 2022; Perumal *et al*., 2013). Research confirms that management systems that improve the antioxidant capacity of the seminal

Conclusion

The results clearly demonstrate that semi-intensive management system significantly improved fresh and post-thaw semen quality in bucks compared to intensive management. Parameters such as progressive motility, livability, acrosomal integrity, and plasma membrane integrity were superior in both fresh and post-thaw, while sperm abnormalities and enzymes leakage (AST and ALT) were lower under semi-intensive conditions. These findings suggest that management system plays a crucial role in determining improved reproductive performance, semen quality and semen freezability of buck semen.

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