

Effect of breed differences on the quality of BTS-diluted boar semen under intensive management system

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Abstract

Boar semen quality may vary according to breed and semen processing methods. This study aimed to evaluate the quality of fresh semen (S1) and semen diluted with Beltsville Thawing Solution (BTS) (S2) collected from Yorkshire (B1), Duroc (B2), and Landrace (B3) boars maintenance under an intensive management system. Semen was collected using the gloved-hand method and evaluated both macroscopically (volume, pH, color, odor, and consistency of semen) and microscopically (sperm concentration, motility, viability, and morphological abnormalities). Data were analyzed using a completely randomized factorial design 3×2 . The results showed that semen type significantly affected ($P < 0.05$) pH, sperm concentration, and semen volume. Fresh semen exhibited higher pH and sperm concentration but lower volume compared with BTS-diluted. Breed did not significantly influence macroscopic semen characteristics. However, significant differences ($P < 0.05$) in sperm motility and viability were observed among breeds, with Landrace boars demonstrating the highest values. No significant differences ($P > 0.05$) were found between fresh and diluted semen within the Landrace breed. Sperm morphological abnormalities were not significantly affected by either breed or semen type. All semen samples showed normal macroscopic characteristics, including milky-white color, typical odor, and watery consistency. In conclusion, semen quality in boars was influenced by both semen type and breed, with Landrace boars exhibiting superior overall semen quality parameters under intensive management conditions.

Keywords: Fresh semen; BTS extender; Semen quality; Boar breed; Semen evaluation

1. Introduction

Pigs production represent an important livestock sector with considerable economic potential in Indonesia due to its high reproductive efficiency and rapid growth performance. Pigs are classified as prolific animals, capable of producing multiple piglets per farrowing, which contributes to high annual productivity [1]. In 2024, the pig population in Indonesia reached 4,115,030 head, with 517,311 head recorded in Bali Province [2]. However, the outbreak of African Swine Fever (ASF), since late 2019 has significantly reduced pig populations and negatively affected the sustainability of pig farming system [3].

Efforts to restore and increase pig population and productivity require improvements in genetic quality and reproductive efficiency. Productivity in pigs is commonly evaluated based on sow prolificacy and growth performance, including efficient feed utilization for meat production [4]. One of the most effective strategic for genetic improvement in the application of artificial insemination (AI) using semen from genetically superior boars, such as Yorkshire, Landrace, and Duroc breeds [5].

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The success of AI programs largely depends on semen quality. Generally, semen suitable for AI should exhibit a minimum progressive motility of 70% and a maximum morphological abnormality rate of 20% [6]. In addition to semen quality, fertility of the sow and technical competence during insemination also influence reproductive outcomes. Several intrinsic and extrinsic factors affect semen quality, including age, nutrition, health status, breed, and environmental conditions [7]. Mature boars typically produce semen with superior quality compared to excessively young or aged boars [8,9]. Breed-related differences have also been reported, with variations observed in sperm motility, viability, and other functional parameters [10]. Consequently, breed selection becomes particularly important in the application of diluted semen for AI programs [11].

Furthermore, semen collection, processing, dilution, and storage procedures may compromise sperm quality by reducing motility, viability, plasma membrane integrity, and acrosomal integrity, and may even induce DNA damage. Spermatozoa with normal morphology, intact chromatin structure, and adequate motility and viability exhibit higher fertilizing potential [12]. Based on these considerations, this study was conducted to evaluate the effect of breed differences on the quality of BTS-diluted boar semen under an intensive management system.

2. Materials and Methods

2.1. Materials

This study was conducted at the Regional Artificial Insemination Center of Bali, where an intensive management system is implemented. Semen evaluation was performed at the same facility and at the Animal Reproduction Laboratory, Faculty of Animal Husbandry, Udayana University. The experimental animals consisted of: Yorkshire, Duroc, and Landrace boars aged 4-6 years. All boars were clinically healthy, exhibited normal libido, and were housed individually under uniform feeding and management conditions throughout the study period.

2.2. Methods

The experiment was arranged in a completely randomized design (CRD) with a 3×2 factorial scheme. The first factor was breed (B): Yorkshire (B1), Duroc (B2), and Landrace (B3). The second factor was semen type (S): fresh semen (S1) and semen diluted with Beltsville Thawing Solution (BTS) (S2). This design resulted in six treatment combinations, with five replicates per treatment. Semen was collected using the gloved-hand method. The sperm-rich fraction was collected into a sterile tube pre-warmed to approximately 37°C. Immediately after collection, semen was subjected to macroscopic and microscopic evaluation. Semen dilution was performed using BTS extender at dilution ratios of 1:2 or 1:3 (semen : BTS), depending on initial sperm concentration and motility. Diluted semen samples were stored at 20°C until evaluation.

Macroscopic evaluation included semen volume, color, odor, pH, and consistency. Microscopic evaluation was conducted using a light microscope at 400× magnification. Sperm concentration was determined using a haemocytometer. Total sperm motility was assessed manually by visual estimation under a microscope using a warmed slide. Sperm viability was evaluated using eosin-nigrosin staining, where unstained spermatozoa were classified as viable and stained spermatozoa as non-viable. Morphological abnormalities were assessed by examining stained smears and expressed as a percentage of abnormal spermatozoa.

Data were analyzed using two-way analysis of variance (ANOVA) based on the 3×2 factorial CRD. When significant effects ($P < 0.05$) were detected, mean comparisons were performed using Duncan's multiple range test [13].

3. Results and Discussion

3.1. Semen Quality in Different Breeds Based on Macroscopic Evaluation

Macroscopic semen characteristics, including volume, pH, color, odor, and consistency, were evaluated as part of the initial assessment of semen quality. The results presented in Table 1 show that semen type significantly affected ($P < 0.05$) total semen volume. Semen diluted with BTS (S2) exhibited a significantly greater volume compared with fresh semen (S1). In contrast, breed did not significantly influence ($P > 0.05$) semen volume. Likewise, no significant interaction between breed and semen type was observed for this parameter. The increase in volume observed in diluted semen reflects the addition of extender during the dilution process, which increases the final volume without reducing the total number of viable spermatozoa per ejaculate [14].

Table 1 Mean values of macroscopic semen quality parameters in fresh semen (S1) and BTS-diluted semen (S2) from different boar breeds

Parameter	Semen ²⁾	Breed ¹⁾			Mean	SEM ³⁾
		B1	B2	B3		
Sperm Volume (mL)	S1	280	216	200	232 ^B	30,2
	S2	1392	1088	1360	1280 ^{A 4)}	
	Mean	836 ^{a 4)}	652 ^a	780 ^a		
pH	S1	7,54	7,58	7,54	7,55 ^A	0,016
	S2	6,54	6,56	6,54	6,55 ^B	
	Mean	7,04 ^a	7,07 ^a	7,04 ^a		
Color	S1	Milky white	Milky white	Milky white	Milky white	-
	S2	Milky white	Milky white	Milky white	Milky white	
Odor	S1	Typical semen	Typical semen	Typical semen	Typical semen	-
	S2	Typical semen	Typical semen	Typical semen	Typical semen	
Consistency	S1	Watery	Watery	Watery	Watery	-
	S2	Watery	Watery	Watery	Watery	

Note : B1: Yorkshire breed; B2: Duroc breed; B3: Landrace breed; S1: fresh semen; S2: semen diluted with BTS; SEM = Standard Error of the Treatment Means

Values followed by the same lowercase letters within a row indicate no significant difference ($P > 0.05$), whereas values followed by different uppercase letters within a column indicate a significant difference ($P < 0.05$).

The semen pH decreased significantly ($P < 0.05$) from approximately 7.5 in fresh semen (S1) to around 6.5 in semen diluted with BTS extender (S2). This reduction is a typical response to the addition of extenders, which generally contain buffering agents and other components that lower the pH. The mildly acidic environment helps maintain sperm stability by limiting excessive metabolic activity, thereby prolonging semen viability during storage. However, deviations from the optimal pH range may adversely affect sperm motility and viability [15].

Both fresh and diluted semen samples exhibited milky white color, characteristic semen odor, and watery consistency, indicating that the physical properties met acceptable quality standards without signs of contamination or deterioration [6]. These observations suggest that the intensive management and semen collection procedures were performed according to established protocols [15].

3.2. Semen Quality in Different Breeds Based on Microscopic Evaluation

Microscopic evaluation provides a detailed assessment of sperm quality, including sperm concentration, motility, viability, and morphological abnormalities, which are critical parameters for determining fertilizing potential [16].

Microscopic evaluation revealed significant differences ($P < 0.05$) in sperm concentration between fresh semen (S1) and BTS-diluted semen (S2), while no significant differences were observed among breeds ($P > 0.05$). A reduction in sperm concentration following dilution is expected, as semen is diluted to achieve an optimal insemination volume containing an adequate number of spermatozoa, while maintaining the total sperm count per insemination dose to preserve fertility [15].

Table 2 Mean values of microscopic semen quality parameters in fresh semen (S1) and BTS-diluted semen (S2) from different boar breeds

Parameter	Semen ²⁾	Breed ¹⁾			Mean	SEM ³⁾
		B1	B2	B3		
Spermatozoa Concentration (10 ⁶ /mL)	S1	178.8	182.0	249.2	203.3 ^{A 4)}	4.24
	S2	25.5	25.82	25.44	25.59 ^B	
	Mean	102.15 ^{a 4)}	103.91 ^a	137.32 ^a		
Spermatozoa Motility (%)	S1	70	71	73	71.33 ^A	0.14
	S2	71	71	73	71.67 ^A	
	Mean	70.5 ^b	71 ^b	73 ^a		
Spermatozoa Viability (%)	S1	74.5	71	75	73.5 ^A	0.18
	S2	73	72	74	73.0 ^A	
	Mean	73.7 ^b	71.5 ^b	74.5 ^a		
Spermatozoa Abnormalities (%)	S1	16.2	14.8	17.0	16.0 ^A	0.10
	S2	15.0	15.0	15.6	15.2 ^A	
	Mean	15.6 ^a	14.9 ^a	16.3 ^a		

Note : B1: Yorkshire breed; B2: Duroc breed; B3: Landrace breed; S1: fresh semen; S2: semen diluted with BTS; SEM = Standard Error of the Treatment Means; Values followed by the same lowercase letters within a row indicate no significant difference ($P > 0.05$), whereas values followed by different uppercase letters within a column indicate a significant difference ($P < 0.05$).

Sperm motility in fresh semen (S1) was satisfactory, with a mean value of 71.33% (Table 2), and did not differ significantly ($P > 0.05$) from BTS-diluted semen (S2), which had a mean of 71.67%. Among breeds, Landrace boars exhibited the highest motility (73%), which was significantly greater ($P < 0.05$) than that of Yorkshire and Duroc, indicating superior motility performance. Sperm motility remains a principal indicator of fertilizing potential [15]. Sperm viability was also highest in Landrace boars, with mean values of 75% in fresh semen and 74% in diluted semen, significantly exceeding those of Yorkshire and Duroc ($P < 0.05$). High viability supports sperm survival and functionality during insemination procedures [17]. The superior motility and viability observed in Landrace boars may be associated with genetic factors and optimal husbandry conditions. Breed-related differences in semen quality, including concentration, motility, and viability, reflect underlying genetic variation among boar breeds [10]. Furthermore, interactions between breed and semen type may affect semen quality through multifactorial mechanisms. The proportion of spermatozoa with morphological abnormalities was low (<17%) and did not differ significantly among breeds or semen types, indicating a healthy sperm population consistent with accepted standards for boar semen quality [17].

4. Conclusion

Semen type significantly affects semen volume, pH, and sperm concentration, with fresh semen exhibiting higher pH and sperm concentration, while BTS-diluted semen shows increased volume but reduce pH and concentration. Breed differences influence sperm motility and viability, with Landrace boars demonstrating the highest overall semen quality parameters under intensive management conditions.

Compliance with ethical standards

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Disclosure of conflict of interest

The author declares that no commercial, financial, or personal relationships could be construed as influencing the results of this study.

Statement of ethical approval

The experimental use of three boars was reviewed and authorized by the Animal Ethics Committee of the Faculty of Veterinary Medicine, Udayana University.

References

- [1] Matiz Villamil, A., Mendez-Carranza, K. J., Pascagaza-Pulido, A. F., Rendon-Rendon, T., Noriega-Noriega, J., and Puli do Villamarin, A. (2023). Trends in the management of organic swine farm waste by composting: A systematic review. *Heliyon*.
- [2] Directorate General of Livestock and Animal Health. (2024). Livestock population by province. <https://www.bps.go.id/>
- [3] Penrith, M.-L., Vosloo, W., Jori, F., and Bastos, A. D. (2013). African swine fever virus eradication in Africa. *Virus Research*, 173(1), 228–246. <http://dx.doi.org/10.1016/j.virusres.2012.10.011>
- [4] Silalahi, P. (2022). Application of reproductive biotechnology to improve pig productivity in North Sumatra. *Jurnal Visi Eksakta*, Faculty of Animal Science, HKBP Nommensen University, Medan. <https://ejournal.uhn.ac.id/index.php/eksakta/>
- [5] Sumardani, N. L. G., Tuty, L. Y., and Siagian, P. H. (2008). Viability of boar spermatozoa in modified BTS (Beltsville Thawing Solution) extender under different storage conditions. *Media Peternakan*, 31(2), 81–86. <https://journal.ipb.ac.id/index.php/mediapeternakan/article/view/1085>
- [6] National Standardization Agency of Indonesia. (2023). Liquid boar semen. No. 8034
- [7] Ismaya, K. G., Suharyati, S., and Yulianto, M. (2019). Semen quality of Landrace boars at different collection frequencies. *Journal of Animal Production and Processing Technology*, 7(2), 55–62.
- [8] Sumardani, N. L. G., Budaarsa, K., Putri, T. I., and Puger, A. W. (2019). Age influences semen volume and spermatozoa motility of Landrace boars at the Baturiti Artificial Insemination Center, Tabanan, Bali. *Jurnal Veteriner*, 20(3), 324. <https://doi.org/10.19087/jveteriner.2019.20.3.324>
- [9] Ardi, M. Y., Tophianong, T. C., and Gaina, C. D. (2024). Fresh semen quality of boars based on age and breed in Kupang Regency. *Jurnal Veteriner Nusantara*, 7(1), 119–128. <https://doi.org/10.35508/jvn.v7i1.12064>
- [10] Johnson, L. A., Weitze, K. F., Fiser, P., and Maxwell, W. M. C. (2000). Storage of boar semen. *Animal Reproduction Science*, 62(1–3), 143–172.
- [11] Parayana, I. G. S., Sumardani, N. L. G., Siti, N. W., and Bidura, I. G. N. (2025). Characteristics and morphology of sperm from crossed Duroc boars at different shelter time frequencies. *World Journal of Biology, Pharmacy and Health Sciences*, 1–7.
- [12] Sumardani, N. L. G., Putra, D. K. H., Budaarsa, K., Mahardika, I. G., and Arifiantini, R. I. (2021). Sperm morphological assessment of Bali boar semen collected from three areas on Bali Island, Indonesia. *International Journal of Fauna and Biological Studies*, 8(2), 54–57. <https://doi.org/10.22271/23940522.2021.v8.i2a.812>
- [13] Steel, R. G. D., and Torrie, J. H. (1993). *Principles and Procedures of Statistics*. Jakarta: Gramedia Pustaka Utama.
- [14] Ax, R. L., Dally, M., Didion, B. A., Lenz, R. W., Love, C. C., Hafes, B., and Bellin, M. E. (2000). Semen evaluation. In B. Hafes and E. S. E. Hafes (Eds.), *Reproduction in Farm Animals* (7th ed., pp. 365–389).
- [15] Knox, R. V., and Rodriguez-Martinez, H. (2012). Boar semen evaluation: Techniques and applications. *Theriogenology*, 78(8), 1715–1722. <https://doi.org/10.1016/j.theriogenology.2012.06.002>
- [16] Arifiantini, R. I. (2012). *Semen Collection and Evaluation Techniques in Animals*. Bogor: IPB Press.
- [17] Parera, H., and Lenda, V. (2023). Evaluation of motility, viability, and abnormalities of boar spermatozoa in various modified extenders. *Journal of Applied Agricultural and Animal Sciences*. <https://doi.org/10.23960/jipt.v11i1.p13-33>