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Descriptive statistics and correlation analysis of semen parameters in Malabari bucks

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Abstract
The study evaluated the quality of goat semen by analyzing key descriptive parameters and their correlations. The fresh semen evaluation was subjected to macroscopic and macroscopic evaluation like volume, concentration (10^6 /mL), viability%, acrosome integrity%, abnormality% and plasma membrane integrity%. The descriptive statistics and correlation analysis was done. The results indicate that the bucks possess exceptionally high-quality semen, as evidenced by a mean sperm concentration exceeding 3,200 million/ml, high viability (84.62%), high acrosome integrity (80.88%), and a low abnormality rate of 4.5%. These descriptive statistics collectively suggest a robust and highly fertile sample, well-suited for breeding and artificial insemination. A negative relationship was observed between sperm concentration and acrosome integrity. Similarly, the correlation between semen volume and sperm concentration was found to be a weak and non-significant negative relationship.

Keywords: Malabari, goat, semen, descriptive statistics, correlation

1. Introduction

Semen quality is a key determinant of reproductive efficiency in livestock and has a direct impact on the success of breeding programs. In goats, semen characteristics such as volume, concentration, motility and viability are routinely evaluated to assess the fertility potential of breeding males. Among indigenous breeds, the Malabari goat is valued for its adaptability, prolificacy and economic importance in Kerala and other parts of India. Understanding and improving the semen quality would be a corner stone for any breeding programme.

Statistical analysis assists in drawing reliable conclusions from experimental data. Descriptive statistics help to understand the distribution of data and correlation analysis helps to understand the interrelationship between the traits. The present study was undertaken to assess the semen characteristics of eight Malabari bucks maintained at the Goat and Sheep farm, Institutional Livestock Farm Complex, College of Veterinary and Animal Sciences, Pookode. The semen traits like volume, colour and density, concentration (106/mL), viability (%), abnormality (%), total sperm (10^6), acrosome integrity (%) and plasma membrane integrity (%) was assessed using descriptive statistics and correlation analysis.

2. Materials and Methods

In the current study, eight healthy adult Malabari bucks aged 2-3 years were selected. Fresh semen samples were collected using artificial vagina method and the semen samples were subjected to the qualitative and quantitative estimation. Macroscopic evaluation was done by the visual inspection of volume, colour and density. Similarly, microscopic evaluation was carried out by evaluating concentration (10^6/mL) where the sperm concentration was calculated by diluting the buck semen at a higher dilution rate of 1:1000, because buck semen is highly concentrated. The diluting fluid was prepared by mixing 4 mL of Eosin-Y solution (2%), 100 ml of Distilled water and 2 ml of Saturated NaCl solution. The semen was diluted by adding 2 mL of the diluting fluid to 2µL of fresh semen. Then, a drop of well mixed diluted semen was loaded between the cover slip and the Neubauer counting chamber. The chamber was left undisturbed for 2 min to settle. Then the sperms were counted under the 400x objective of the microscope.

The sperms present on the top and left side line of each tertiary square were included while sperms lying on the lower and right-side line were excluded while counting. Later viability (%) and abnormality (%) according to Campbell *et al*. (1953) [1], total sperm (10^6), acrosome integrity (%) and plasma membrane integrity (%) according to Selvaraju *et al*. (2008) [6]. The normality of the data was checked using Shapiro-Wilk test and the statistical analysis was done using R 4.5.0 (R Core Team, 2025) [5].

3. Results and Discussion

The descriptive statistical analysis of semen parameters is depicted in the Table 1. and the graphical representation of the mean values of semen parameters is showed in Figure 1 Which revealed the average ejaculate volume was 0.75 ml, with a very narrow range from 0.6 ml to 0.9 ml. Typical ejaculate volume in goats (bucks) ranges from 0.5 to 1.5 ml, but can vary widely based on breed, age, and collection method (Zhang *et al*., 2023) [7]. Our data falls squarely within a normal range for goats, while the volume is modest compared to other species. The average sperm concentration was 3209.38 million per ml, with a range from 3045 to 3427 million/ml. Similar results were recorded by Prasanth (1995) [3] and Ranjini (1998) [4] in Malabari buck semen. A healthy goat's semen concentration is typically in the range of 2,000 to 4,000 million/ml. The concentration in our data is at the upper end of the normal range for goats, indicating an extremely dense and rich sample. This is a key indicator of a buck's high fertility and it is a major advantage for artificial insemination, as a single ejaculate can be diluted into many doses.

On average, 84.62% of the sperm were viable (alive). The range was from 78% to 90%. John (2016) [2] recorded a mean viability of 91 to 92% in good and poor freezability Malabari buck semen. A minimum of 70% viability is generally considered acceptable for goat semen. Our data shows a very high percentage of viable sperm, well above the threshold for high-quality semen. This indicates that the sperm cells are healthy and alive. The average abnormality rate was 4.5%, ranging from 3% to 6%. The abnormality rate in our data is extremely low, indicating a near-perfect morphology across the samples. This is a strong positive indicator of the buck's reproductive health and the high quality of its sperm.

About the acrosome integrity the average was 80.88%, with a tight range from 78% to 83%. While specific ranges for goats are less commonly reported than in other species, according to our observations a high percentage of intact acrosomes is always a sign of high-quality semen, this value suggests that the majority of sperm cells are structurally sound and have the necessary enzymes to fertilize an egg. The average plasma membrane integrity was 78%, with a range from 75% to 81%. A minimum of 60% plasma membrane integrity is often used as a benchmark. Some studies report ranges up to 85% for high-quality semen. This high percentage of intact plasma membranes confirms the health of the sperm cells, as the membrane is vital for function and survival.

The average total sperm count was 2405.84 million, with a range from 1887.6 to 2740.5 million. The total sperm count is the product of volume and concentration. Getting the high concentration, the total number of sperms here is far above the typical values used for commercial purposes. A high total sperm count is invaluable for artificial insemination, as it allows a single ejaculate to be processed into a greater number of individual doses, increasing the breeding efficiency of a valuable buck.

Semen is a complex fluid, and its parameters are not independent. For example, a high sperm concentration may not guarantee fertility if the sperm are not motile or have poor morphology. The correlations between the existing factors reveal if the sample is not only numerous but also functionally robust. The pair wise correlation matrix of semen parameters is graphically visualized in the Figure 2 The correlation between abnormal sperm and acrosomal integrity is showed in Figure 3 which reveals a negative relationship ($r=-0.773$) and was statistically significant ($p<0.05$) indicating as the percentage of abnormal sperm increases, the percentage of sperm with intact acrosomes decreases. The correlation between sperm concentration and acrosome integrity is showed in Figure 4 which reveals a negative correlation ($r=-0.531$) and was not statistically significant. This negative number shows an inverse trend. It suggests that as sperm concentration increases, acrosome integrity tends to decrease. The correlation between semen volume and sperm concentration is showed in Figure 5 which reveals a negative relationship ($r=-0.122$) and was statistically not significant suggesting a weak relationship inverse and there's a slight tendency for sperm concentration to decrease as semen volume increases.

4. Conclusion

The descriptive statistics observed for the goat semen samples indicate high quality, especially in terms of concentration, viability, and morphology. This level of quality could be the result of careful selection of the animals, their diet, or environmental factors. Correlation analysis showed some weak trends in the sample data and they are not strong enough to be considered reliable or to support any definitive conclusions. This can be due to the small sample number for the current study. Similar studies with larger sample size need to be conducted in future to assess the semen parameters of the Malabari goat breed.

Table 1: Descriptive statistical summary of the Malabari buck semen parameters

Parameter	N	Mean	Standard deviation	Minimum	Maximum	Median	Standard error
Volume (ml)	8	0.75	0.09	0.6	0.9	0.75	0.03
Concentration (10^6/ml)	8	3209.38	120.62	3045	3427	3206	42.65
Viability (%)	8	84.62	3.78	78	90	84.5	1.34
Acrosome Integrity (%)	8	80.88	1.64	78	83	81	0.58
Abnormality (%)	8	4.5	1.07	3	6	4	0.38
Plasma Membrane Integrity (%)	8	78	2.14	75	81	78	0.76
Total Sperm (10^6)	8	2405.84	293.32	1887.6	2740.5	2503.45	103.71

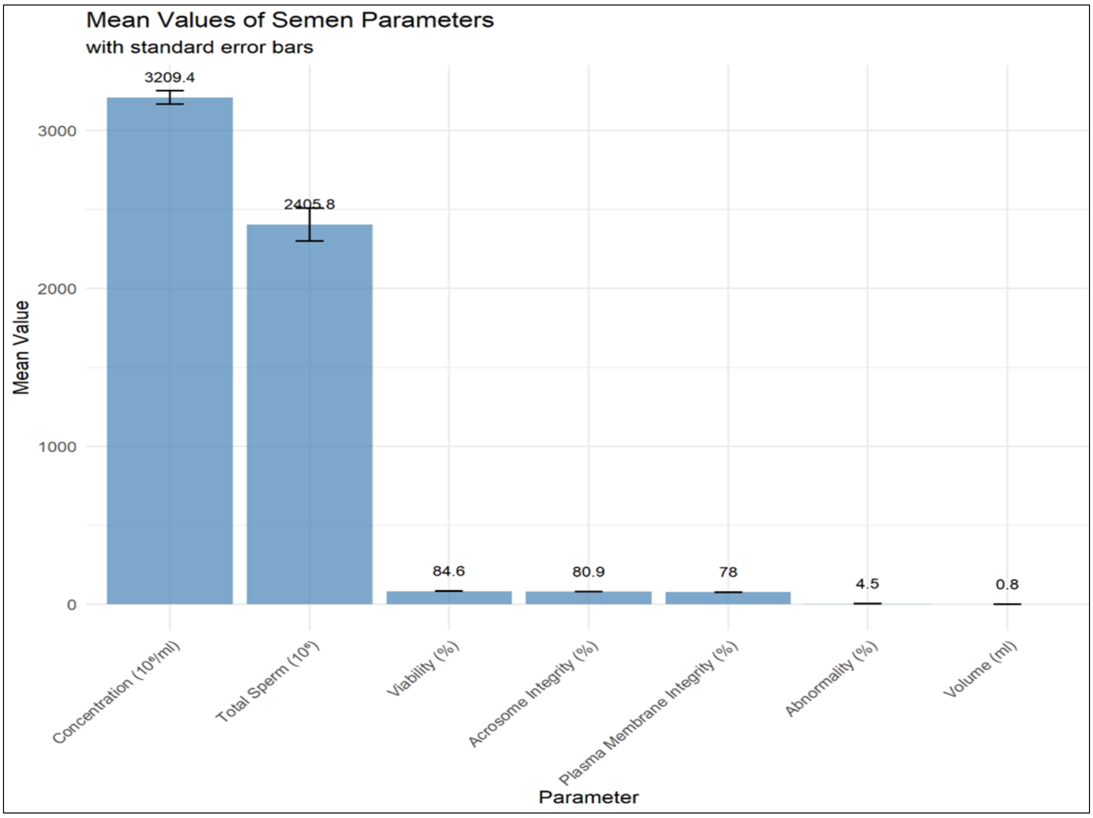

Fig 1: Mean values of the Malabari buck semen parameters

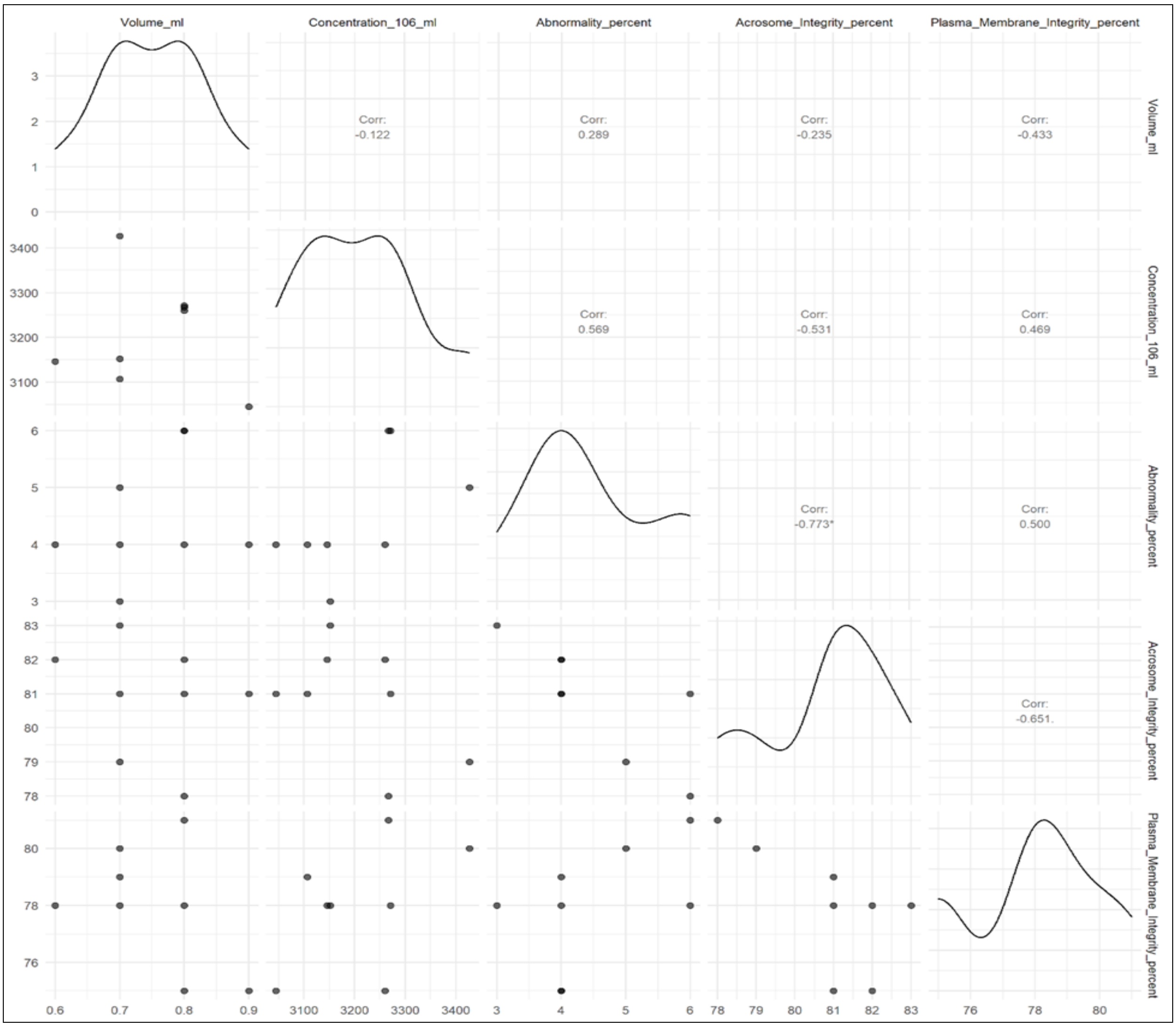

Fig 2: Pair wise correlation matrix of Malabari buck semen parameters

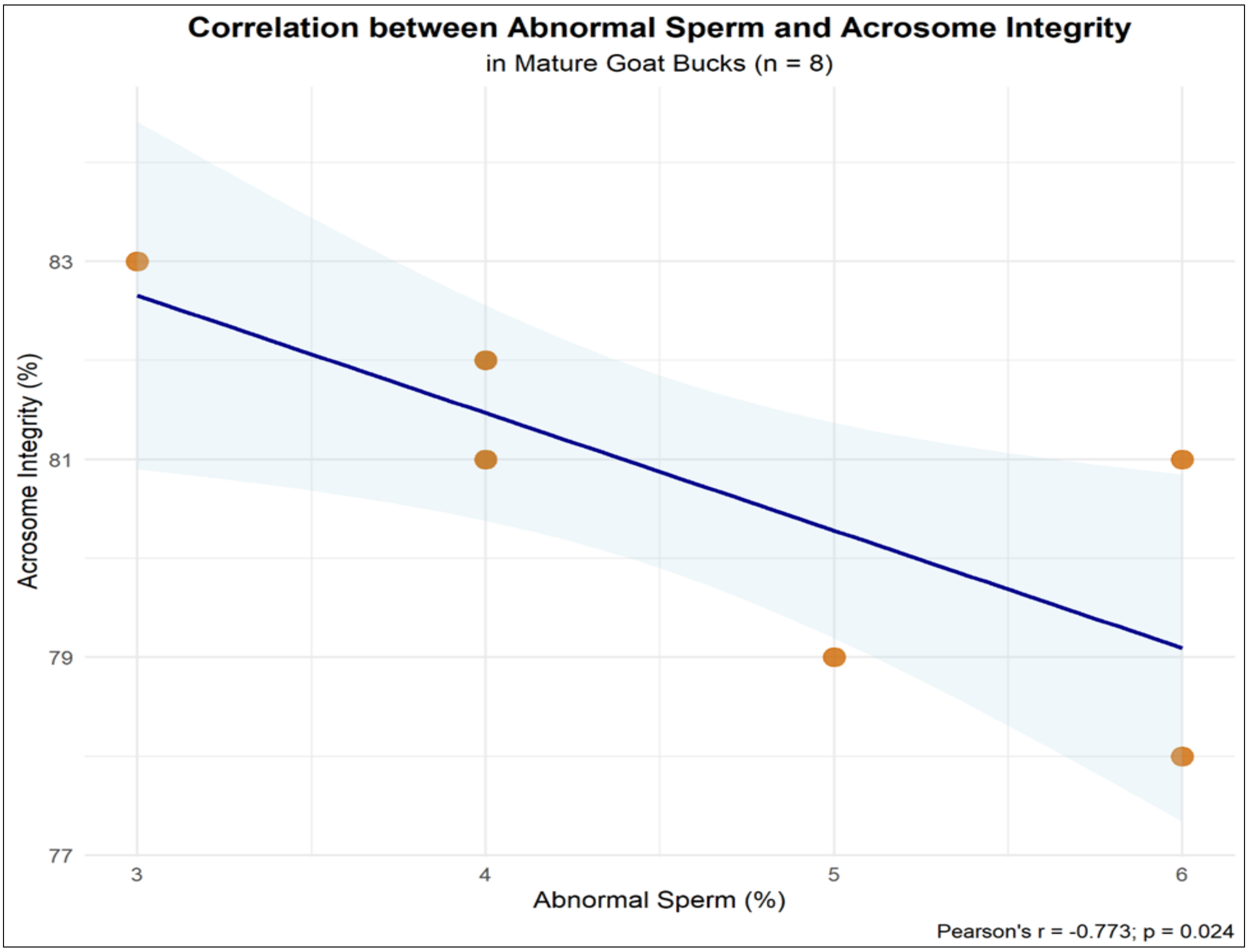

Fig 3: Correlation between abnormal sperm and acrosomal integrity

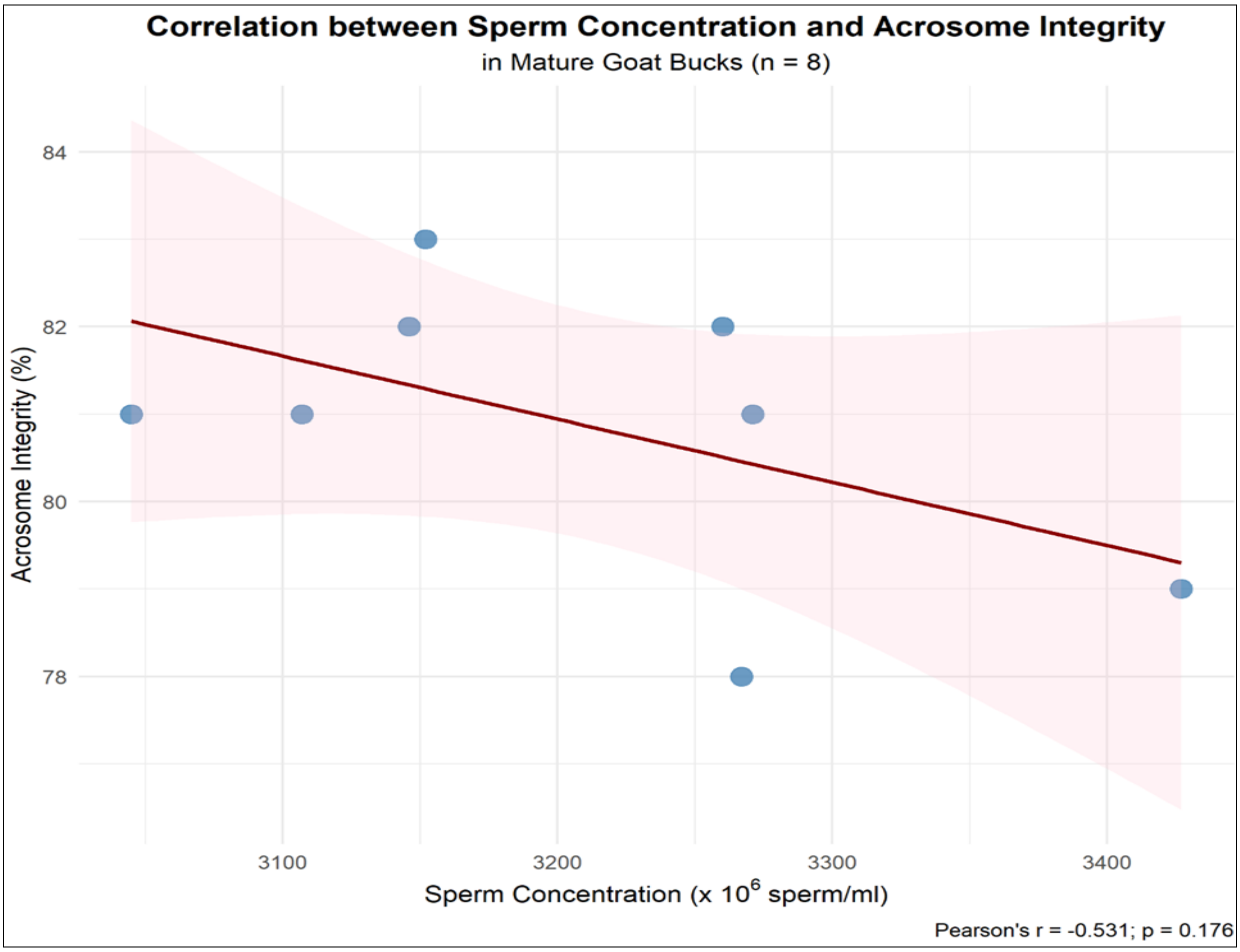

Fig 4: Correlation between sperm concentration and acrosome integrity

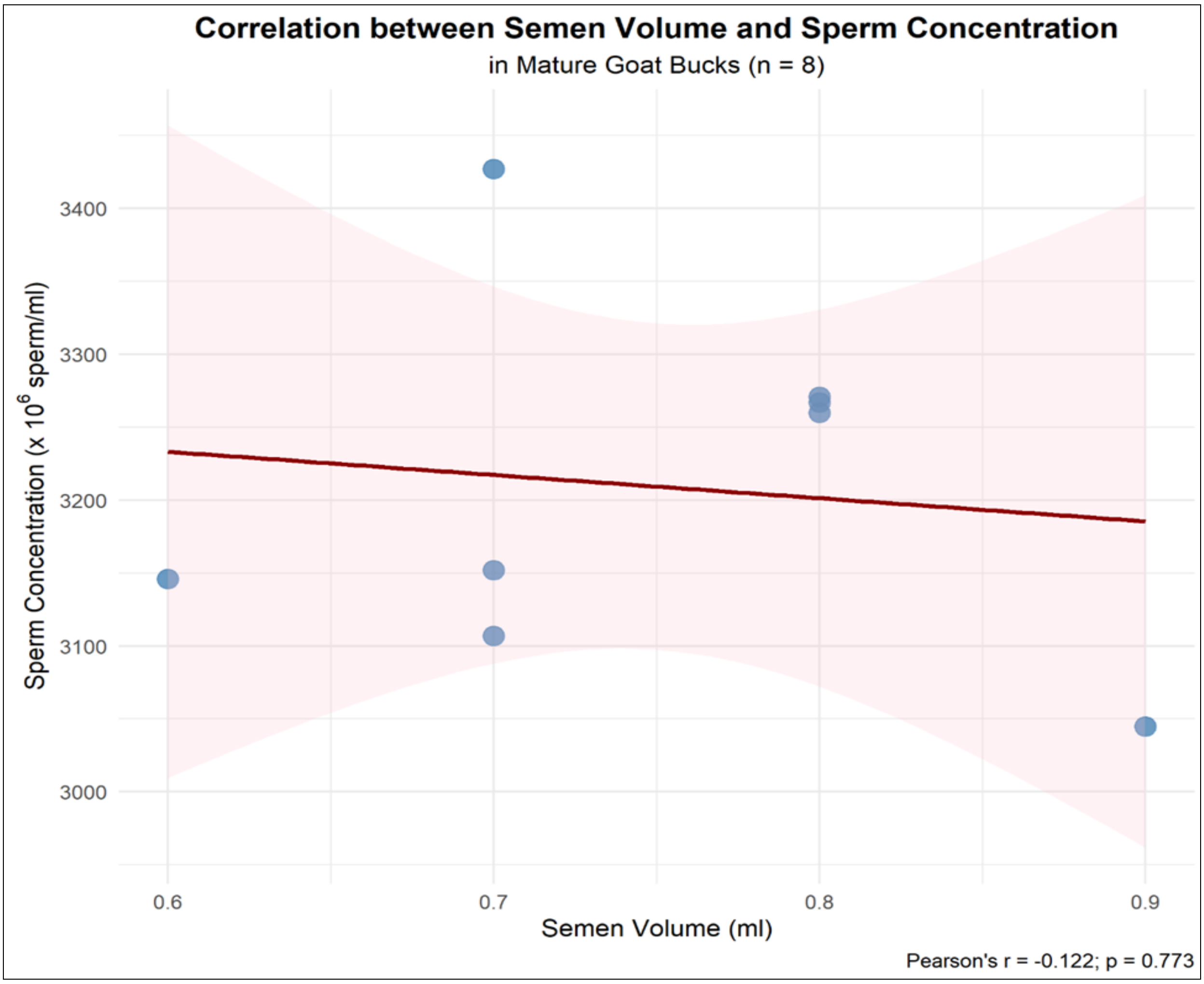

Fig 5: Correlation between semen volume and sperm concentration

Conflict of Interest
Not available

Financial Support
Not available

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