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Assessment of FMD vaccination on semen quality parameters in Vrindavani bulls

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Abstract
This study aimed to investigate the impact of FMD vaccination on seminal parameters at the Germ Plasm Centre (GPC), ICAR-IVRI, India. Three Vrindavani breeding bulls selected were subjected to the same feeding and management practices. Six ejaculates (3*2) were collected from each bull, with the first collection occurring one week before vaccination and the subsequent collections spanning six weeks after vaccination with the RAKSHA-OVAC TRIVALENT FMD vaccine (concentrated) using an oil adjuvant from Indian Immunological Ltd. Seminal quality parameters, including ejaculate volume (ml), sperm concentration million/ml), viability (%), and sperm abnormalities (%), were meticulously assessed for all ejaculates. The data from the ejaculates were subjected to statistical analysis, which involved calculating descriptive statistics such as mean values and standard errors, along with a one-way analysis of variance. Mean comparisons were conducted using Fisher pairwise comparison at a 5% significance level. The results indicated that the impact of FMD vaccination on these parameters was statistically significant (p<0.05) when compared to both the pre-vaccination and the first-week post-vaccination periods. Notably, the volume of semen per ejaculate remained relatively consistent, suggesting that it was not significantly affected by the Foot and Mouth Disease (FMD) vaccination, in contrast to the significant effects observed on sperm concentration, viability, and sperm abnormalities (p<0.05).

Keywords: Vrindavani bulls, FMD vaccination, volume, sperm concentration, viability, sperm abnormality

Introduction
Numerous instances of foot and mouth disease (FMD), a disease inherent to cloven-hoofed animals, manifest annually across the nation. As a preventive strategy to avert its emergence at semen stations, FMD vaccinations are routinely administered to breeding bulls (Bhakat *et al*., 2011) [3]. Vaccination-induced stress and anaphylactic shock can potentially impact the quality of semen (Murugavel *et al*., 1997) [8]. Diverse accounts exist regarding the influence of Foot and Mouth Disease (FMD) vaccination on semen quality across various breeds of cattle and buffaloes. (Mathur *et al*. 2003, Bhakat *et al.* 2010, Perumal *et al.* 2013) [7, 2, 9]. In the study conducted by Mangurkar *et al.* (2000) [6], it was noted that vaccination did not result in a substantial impact on semen quality. Conversely, other researchers reported a heightened occurrence of sperm irregularities subsequent to vaccination (Bhakat *et al*., 2011; Perumal *et al*., 2013) [3, 9]. Every phase of spermatogenesis (Anderson, 2001) [1] can be impacted, with the intensity of impairment contingent upon the scope and duration of thermal stress (Waites and Setchell, 1990) [13]. Nevertheless, the outcomes regarding the influence of vaccination on semen quality in breeding bulls exhibit discrepancies, potentially stemming from breed-specific attributes or the degree of inheritance in crossbred animals. Hence, the current investigation was conducted to evaluate the semen quality parameters following Foot and Mouth Disease (FMD) vaccination in Murrah, Sahiwal, and Vrindavani bulls.

Material and Methods
The aim of this research was to evaluate the effects of FMD vaccination with an oil adjuvant vaccine on the semen of breeding bulls, both before and after vaccination. This study focused on Vrindavani breed bulls and involved a total of 3 bulls, resulting in the collection of 42 ejaculates. Prior to vaccination, two ejaculates were collected from each bull, resulting in six ejaculates. Subsequently, post-vaccination, two ejaculates per bull per week were collected for six weeks, resulting in a total of 36 ejaculates per breed.

In total, 42 ejaculates were meticulously examined, assessing various seminal parameters such as volume (ml), sperm concentration (million sperm per milliliter), viability (%), and sperm abnormality (%). The volume of semen was measured using graduated collection tubes, and semen concentration was determined using a bovine photometer, and Eosine and nigrosine were employed to assess sperm viability and evaluate sperm abnormalities. The data collected before and after vaccination were subjected to rigorous analysis using standard statistical methods (Snedecor and Cochran, 1994) [11] and the statistical analysis software Minitab version 21.4. Mean comparisons were conducted using Fisher pairwise comparison, with a significance level of 5%.

Result and Discussion

Table 1: Means±SE of semen quality parameters during pre and post FMD vaccination period

	Parameters	Prevaccination	Post vaccination					
			1 week	2 week	3 week	4 week	5 week	6 week
Vrindavani	Volume(ml)	2.93^{a}±0.48	3.42^{a}±0.66	3.70^{a}±0.64	3.02^{a}±0.25	2.90^{a}±0.33	2.93^{a}±0.48	3.33^{a}±0.60
	Concentration (million/ml)	716.70^{ab}±54.30	500.30^{c}±26.50	629.50^{bc}±32.10	689.70^{ab}±64.80	708.20^{ab}±49.00	720.70^{ab}±54.30	826.20^{a}±40.40
	Sperm abnormality (%)	6.87^{c}±0.47	20.22^{a}±1.07	15.63^{b}±0.64	14.50^{b}±0.85	13.83^{b}±0.94	8.30^{c}±0.53	6.89^{c}±0.47
	Viability (%)	81.90^{a}±1.32	63.83^{e}±3.37	65.33^{de}±3.36	71.67^{cd}±4.61	76.87^{bc}±2.66	80.78^{ab}±0.67	85.86^{a}±0.92

Values have been presented as Mean±Standard Error; Means with different superscripts within a row differ significantly (≤0.05)

When compared with pre-vaccinated week sample ejaculates (to be called Control samples/control ejaculates from now onwards) the changes in semen Volume pre- and post-vaccination were not significant and were almost similar to pre-vaccination stage.

In the instance of Vrindavani bulls (Table 1), the Mean±SEM measurements of crucial semen attributes were evaluated. These attributes encompass sperm concentration (716.70±54.30 vs. 500.30±26.50), and viability (81.90±1.32 vs. 63.83±3.37). Notably, these measurements experienced a significant reduction (p<0.01), while there was a corresponding elevation in sperm abnormality (6.87±0.49 vs. 20.22±1.07). In the initial week following vaccination, a pronounced decline was observed in sperm concentration by 30%, and sperm viability by 22% when compared to control fresh ejaculates. Simultaneously, there was a substantial 194% increase in sperm abnormalities when juxtaposed with the control group. During the second week post-vaccination, there were indications of an enhancement in the quality of fresh semen. Nevertheless, these values persisted as statistically significant (p<0.05) when compared to both the pre-vaccination and first-week post-vaccination periods. The volume of semen per ejaculate displayed no significant fluctuations, implying an independent status in relation to Foot and Mouth Disease (FMD) vaccination.

Average values of semen quality parameters for Vrindavani bulls during pre- and post- FMD vaccination period are given in Table 1. The semen volume per ejaculate showed no appreciable changes and looked to be independent of FMD vaccination. Bhakat *et al.* (2008) [4], Mangurkar *et al.* (2000) [6] and Singh *et al.* (2003) [7] reported similar findings in volume of semen due to FMD vaccination means no change in volume of semen due to FMD vaccination. However, Venkatareddy *et al.* (1991) [12] reported disagreement of findings in Ongole, Jersey and Ongole × Jersey breeds. Volume of semen, increased slightly during postvaccination period in Karan Fries and Murrah buffalo bulls (Bhakat *et al.* 2010) [2]. A steadily decrease in the volume of semen was observed during remaining post-vaccination period. Concentration of spermatozoa did not change significantly due to vaccination. However, slightly higher concentration was recorded during post-vaccination period, which might be due to the presence of increased number of casts and subsequent counting by photometer. However, Bhakat *et al.* (2008) [4] reported a significant decrease in sperm concentration/ml of semen following FMD vaccination in Sahiwal bulls. Significant change was also observed for live percentage of spermatozoa during post-vaccination period. Saha *et al.* (2011) [10] reported a specific decrease in live sperm percentage in HF bull from 95.23% to 83.19% and 84.57% in the period up to 20 days post-vaccination, followed by significant improvement (90.18%) afterward. Some studies have focused on sperm abnormalities such as total, head, tail, and mid piece abnormalities, which were found to increase after vaccination. The increase in temperature following vaccination affects the microenvironment around spermatocytes and epididymal spermatozoa, leading to these abnormalities (Gahlot *et al.*, 1990; Venkatareddy *et al.*, 1991) [5, 12].

Conclusion

Based on the latest research findings, it can be inferred that vaccinating Vrindavani breeding crossbreed bulls for FMD (Foot-and-Mouth Disease) has a negative impact on several seminal parameters. This is primarily attributed to the febrile reaction triggered by the vaccination, which subsequently leads to an elevation in testicular temperature and disrupts the normal process of spermatogenesis. Consequently, the bull's performance experiences a temporary decline, the duration of which is contingent upon the duration of the febrile reaction within the animal's system.

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