EFFECT OF FMD VACCINATION ON VARIOUS SEMEN CHARACTERISTICS OF SAHIWAL BULLS

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INTRODUCTION

In India vaccination of breeding bulls especially those kept for the purpose of artificial insemination is a regular prophylactic measure. These bulls are vaccinated against various contagious diseases which are both bacterial and viral. Although vaccination of both Indian breeds and exotic bulls has become a prerequisite but the available reports on the effect of vaccination on various semen parameters are very contradictory. A number of researchers have earlier reported the increased incidence in sperm abnormalities following vaccination in various breeds (Venkataswami and Rao (1970); Rao and Venkataswami (1974) and Kammar and Gangadhar, (1998)). In contrast, Mangurkar et al. (2000) observed that vaccination did not affect the ejaculate volume, initial motility, pre freezing motility and post freezing motility. During post vaccination period, occurrence of a febrile reaction causes rise in body temperature as well as that of the testis (Gahlot and Kohli 1981; Venkatareddy et al., 1991 and Murugavel et al., 1997). This rise in testicular temperature acts as a stress factor as there is a corresponding decline in the proportion of progressively motile and live spermatozoa and a subsequent increase in the incidence of morphologically abnormal spermatozoa, especially those with defective heads (Barth and Oko, 1989). The recovery is dependent upon the nature and duration of the thermal insult. The rise in body temperature has its deleterious effect on both the process of spermatogenesis (Venkatareddy et al., 1991) and even on the fully formed sperm (Anderson, 2001). All stages of spermatogenesis are susceptible, with the extent of damage related to the extent and duration of the increased temperature (Waites and Setchell, 1990). This may result in decreased fertilization rates and an increased incidence of embryonic death (Burfening and Ulberg, 1968). The administration of vaccines to the animal can also lead to epididymal dysfunction and thereby cause increase in number of spermatozoal abnormalities in the initial stage resulting in reduced motility (Rao and Venkataswami, 1974 and Rao, 1976). Consequently the epididymal sperm reserves start declining, resorption of abnormal sperms increases (Rao et al., 1980) which leads to a fall down in sperm concentration. Considering the type of vaccine, compared to bacterial vaccine, viral vaccine has more of deleterious effects. With the administration of viral vaccine both the metabolic activity and 'cold shock' resistance of sperm are reduced to a considerable level (Venkataswami et al., 1972). Persual of literature showed that semen quality of exotic (Saxena and Tripathi, 1977; Gahlot and Kohli, 1981 and Gahlot et al., 1990), crossbred bulls (Venkatareddy et al. 1991 and Mathur et al. 2003) and buffalo bulls (Tripathi and Saxena 1976) is adversely affected by vaccinations against FMD, HS and BQ. But still the information available in concern with the semen quality during post vaccination period in indigenous breeds like Sahiwal bulls is very less.
MATERIALS AND METHODS

The present study was carried out with 6 Sahiwal breeding bulls maintained at Artificial Breeding Complex, NDRI, Karnal, Haryana, India, under standard managemental practices. The observations were recorded for the time span of two years, from 2002 to 2004 and based on this data effect of FMD vaccination was studied on semen quality parameters of bulls. The basic criterion of bulls' selection was that those which produced freezeable quality semen and gave at least 4 ejaculates each during pre-vaccination and post-vaccination period. Semen was collected in the morning by AV technique and on each collection; two ejaculates were taken with a 20 to 30 min gap in between two successive ejaculates. Each ejaculate was preceded by a period of sexual preparation consisting of at least two false mounts separated by about one minute restraint. The semen quality evaluation was done one month before and one month after vaccination. A total of 49 ejaculates were taken before vaccination, which served as control. FMD (concentrated tetravalent) vaccine (Intervet Ltd., India) was administered @ 2.5 ml by SC injection route, which contained FMD virus types O, A, C and Asia 1 strains. A total of 32 ejaculates were collected after vaccination to study the effect of vaccination stress, if any. These ejaculates were subjected to semen evaluation (Ejaculate Volume, Mass Activity, Initial Motility) by standard methods Tomar et al., 1966. Sperm concentration was evaluated by using improved Neubauer's chamber method. The data regarding all the semen quality parameters was adjusted against the season, period and age with respect to significance and then the adjusted data were subjected to least square analysis (Snedecor and Cochran, 1994) to study the effect of non genetic factors on the semen quality parameters.

RESULTS AND DISCUSSION

It is desirable that the bulls kept for AI purpose should be maintained in a disease free area. The bulls are routinely vaccinated against bacterial and viral diseases e.g., foot-and-mouth disease (FMD), haemorrhagic septicaemia (HS) and black quarter (BQ) in the countries where these diseases are prevalent. This is being practiced in all the bull studs and bull mother farms in India. However, the available reports on the effect of such vaccination on semen quality are conflicting. Vaccination is one of the major anaphylactic stress factors that affect the semen quality (Gahlot and Kohli, 1981; Venkatareddy et al., 1991 and Murugavel et al., 1997). Viral vaccination produces more deleterious effect than that with bacterial vaccines (Venkataswami et al., 1972). Foot and Mouth Disease (FMD) vaccination adversely affects the semen quality (Saxena et al., 1976) of exotic and crossbred bulls (Saxena and Tripathi, 1976; Saxena and Tripathi, 1977; Gahlot et al., 1990 and Venkatareddy et al., 1991). Most of the earlier authors (Venkataswamy and Rao, 1970; Rao, 1974 and Tripathi and Saxena, 1976) studied the effect of formalised gel FMD vaccine. The least squares means values for various quantitative and qualitative attributes of semen of 6 sahiwal bulls during pre and post-vaccination periods and analysis of variance for the effect of vaccination are depicted in Table- 1 and 2, respectively and graphically represented in Figs-1 and 2, respectively. In general a declining trend in all the semen quality parameters was observed after vaccination. The mean ejaculate volume (ml) of sahiwal bulls was 4.48 ± 0.24 ml before vaccination and post vaccination the volume was 4.70 ± 0.29 ml, but there was no significant (P>0.05) variation in semen volume during pre- or post- vaccination period in sahiwal bulls, thus signifying that vaccination did not affect the volume of semen. These findings are similar to the reports of Rao (1974); Tripathi and Saxena (1976); Saxena and Tripathi (1977); Kammar and Gangadhar (1998); Mangurkar et al. (2000) and Singh et al. (2003) on semen volume following vaccination. The major portion in the semen is the seminal plasma which is contributed by the accessory sex glands (Roberts, 1986). The secondary activities of accessory sex glands remain unaffected following vaccination (Radhakrishnan et al., 1975). So, this can be considered as a possible cause for no change in the ejaculate volume. However, Venkatareddy et al. (1991) in Onqole, Jersey and Ongole x Jersey breeds reported an increase volume of semen. There was no significant (P>0.05) variation in total volume per day during pre- or post- vaccination period in sahiwal bulls, thus suggesting that vaccination that did not affect the total volume per day. Whereas Mass Activity (MA) was significantly (P>0.05) decreased 2.20 ± 0.14 sahiwal bulls after vaccination. Pre-vaccination progressive motility (%) was 53.41 ± 0.07 %, and after vaccination the value was 48.07 ± 0.11 % respectively. IM was decreased after vaccination, but it was not significant (P>0.05). Similarly, Verma (1996) had reported decrease in motility following administration of the drugs. There was inverse correlation between progressive motility and the tail abnormalities (r=0.64). However, there was a positive correlation between live sperm count and progressive motility (r=0.433). The decrease in sperm motility may be due to the
Table 1. Least-square means ± S.E. for FMD vaccination effect on various semen characteristics of Sahiwal bulls

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Pre-vaccination</th>
<th>Post-vaccination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N LSM ± SE</td>
<td>N LSM ± SE</td>
</tr>
<tr>
<td>Ejaculate Volume (ml)</td>
<td>49 4.48 ± 0.24</td>
<td>32 4.70 ± 0.29</td>
</tr>
<tr>
<td>Volume (ml)/ day</td>
<td>31 7.07 ± 0.60</td>
<td>24 6.27 ± 0.68</td>
</tr>
<tr>
<td>Mass Activity (0-5 scale)</td>
<td>49 2.20 ± 0.12</td>
<td>32 1.73 ± 0.14</td>
</tr>
<tr>
<td>Initial Motility (%)</td>
<td>49 55.41 ± 0.07</td>
<td>32 48.07 ± 0.11</td>
</tr>
<tr>
<td>Sperm concentration (million/ml)</td>
<td>49 737.76 ± 41.21</td>
<td>32 540.63 ± 50.99</td>
</tr>
<tr>
<td>Sperm concentration per ejaculate(million)</td>
<td>49 3244.69 ± 238.21</td>
<td>32 2700.00 ± 294.77</td>
</tr>
</tbody>
</table>

Table 2. Least-square ANOVA for FMD vaccination effect on various semen characteristics of Sahiwal bulls (M.S.S. Values)

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Parameters</th>
<th>Source of Variation</th>
<th>d.f.</th>
<th>M.S.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Volume (ml)</td>
<td>Vaccination</td>
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<td>1.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Error</td>
<td>79</td>
<td>2.71</td>
</tr>
<tr>
<td>2</td>
<td>Volume (ml)/ Day</td>
<td>Vaccination</td>
<td>1</td>
<td>8.73</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Error</td>
<td>53</td>
<td>10.98</td>
</tr>
<tr>
<td>3</td>
<td>Mass Activity (0-4)</td>
<td>Vaccination</td>
<td>1</td>
<td>4.27*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Error</td>
<td>79</td>
<td>0.66</td>
</tr>
<tr>
<td>4</td>
<td>Initial Motility (%)</td>
<td>Vaccination</td>
<td>1</td>
<td>342.77</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Error</td>
<td>79</td>
<td>111.62</td>
</tr>
<tr>
<td>5</td>
<td>Sperm concentration (million/ml)</td>
<td>Vaccination</td>
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<td>752258.2**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Error</td>
<td>79</td>
<td>83225.83</td>
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<td>6</td>
<td>Sperm concentration per ejaculate(million)</td>
<td>Vaccination</td>
<td>1</td>
<td>5743359.84</td>
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<td></td>
<td></td>
<td>Error</td>
<td>79</td>
<td>2780369.88</td>
</tr>
</tbody>
</table>

** P<0.01; *, P<0.05

anaphylactic stress effect of vaccination, which was depicted by the significant rise in body temperature as well as temperature of testes causes derangement in epididymal functions and spermatogenesis by vaccination induced testicular degeneration (Venkatareddy et al., 1991). Sperm cell develops the capacity for motility during their passage through the epididymis (Moulikrishan and Rao, 1986). Epididymal dysfunction following vaccination could be the possible cause for decline in motility. Effect of temperature on the fully formed epididymal spermatozoa could give rise to secondary abnormalities (Venkataswami and Rao, 1970). Although heating seems to affect Sertoli and Leydig cell function, germ cells are the most sensitive to heat (Waites and Setchell, 1990). All stages of spermatogenesis are susceptible, with the extent of damage related to the extent and duration of the increased temperature (Waites and Setchell, 1990). Spermatocytes in meiotic prophase are killed by heat, whereas spermatozoa that are more mature usually have metabolic and structural abnormalities (Setchell et al., 1971). Increase in temperature of testis usually decreases the proportion of progressively motile and live spermatozoa, and increases the incidence of morphologically abnormal spermatozoa. Gwazdauskas et al. (2006) reported differences in the embryo quality for embryos obtained after IVF with semen samples from bulls that had an intense response to scrotal insulation, may be due to occurrence of abnormal spermatozoa. Decline in motility may also be due to the increase in sperm tail and mid-piece abnormalities. Rao (1976) had reported low sperm motility associated with high incidence of sperm tail defects as a result of epididymal dysfunction and poor handling in the laboratory. In a personal observation by Anderson (2001), one bull recovered from FMD, the concentration of spermatozoa was normal, but the motility was poor (20 percent); nine weeks later the motility was better (80 percent), since then the bull maintained good sperm production. But on the contrary, Venkataswamy and Rao (1970); Rao (1974); Sexena et al. (1976); Tripathi and Saxena,
(1976); Venkatareddy et al. (1991); Kammar and Gnagadhar (1998) and Singh et al. (2003) have reported significant reduction in the motility of bull semen after vaccination. Saxena and Tripathi (1977); Mangurkar et al. (2000) and Venkatareddy et al. (1991) have reported increase in sperm abnormalities and live sperm count and percent of cold shock resistant sperms during post-vaccination period.

The mean sperm concentration before vaccination was $737.76 \pm 41.21 \times 10^6$ ml in Sahiwal bulls. After vaccination the values were $540.63 \pm 50.99 \times 10^6$ ml.

There was significant decrease ($P>0.01$) in sperm concentration of both the breed following vaccination. Our findings are akin to the earlier reports of Venkataswamy and Rao (1970); Venkatareddy et al. (1991) and Singh et al. (2003). On the contrary, Kammar and Gnagadhar (1998) reported no adverse effect of vaccination on sperm concentration during post-vaccination period. Similar trend like sperm concentration was observed in the case of total sperm output was decreased $3244.69 \pm 238.21$ vs. $2700.00 \pm 294.77$ in sahiwal bulls after vaccination, but it was not significant ($P>0.05$). The decreased sperm concentration may be due to the adverse effects of therapeutic agents on germinal cells resulting into increase in dead spermatozoa, which are absorbed by leucocytes through phagocytosis (Mann and Mann, 1981). The adverse effects of vaccination may be like the adverse effects produced by therapeutic agents or like degenerative changes in germinal epithelium. The increased resorption of abnormal spermatozoa leads to reduction in epididymal sperm reserves (Rao et al., 1980), thus decreasing concentration. So the decreased sperm concentration following vaccination may be probably due to an increase in resorption of spermatozoa in the epididymis.
FMD vaccination and semen characteristics in Sahiwal bulls

The probable causes for febrile reaction during vaccination (Hanly et al., 1998) can be 1. adjuvant used (Contamination, Quality) and 2. antigen used (not purified bacterial antigen, viral antigen not clarified). The degenerative changes in testicular structure can be attributed not only to the post-vaccination febrile reaction but to additional possible factor related to the immunogenic nature of the vaccine as well, since inflammatory reaction was observed in the intertubular space (Sahatpure and Patil, 2003). When testicular temperature increases, metabolism increases at a greater rate than blood flow and hence the testes become hypoxic. Therefore, the testes are very susceptible to temperature increases due to endogenous or exogenous factors (e.g. fever, high ambient temperature). As testicular temperature increases, the proportion of defective spermatozoa increases; recovery is dependent upon the nature and duration of the thermal insult. The testis usually operates on the brink of hypoxia (Setchell, 1978). Increased temperature increases metabolism, with a concurrent need for increased oxygen to sustain aerobic metabolism. However, studies in rams (Setchell, 1978) have shown that blood flow changes little in response to increases in testicular temperature and consequently the testes become hypoxic. Increasing blood oxygen saturation is not practical since the blood is nearly completely saturated under normal conditions. Although increasing blood flow would increase the delivery of oxygen, it would also bring considerable additional heat into the testes. The increased body temperature may affect not only spermatogenesis but also fully formed sperm (Anderson, 2001).

From the above discussions, it is clear that the application of FMD vaccine has an adverse effect. Mass activity and sperm concentration have been affected adversely in sahiwal bulls. Febrile reaction due to vaccination results in to the testicular degeneration although of very mild nature. So, the spermograms affected following vaccination suggests that in bovines, the semen collection and preservation should be suspended till normal fertility of sperm is restored to avoid the failure of conception from AI using such semen.

REFERENCES


Bhakat, Mohanty, Gupta, Raina, Mondal and Khan