Prebreeding Immunization of Beef Cows

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Summary

A number of infectious agents are potential threats to the fetus of a pregnant cow and may result in abortion. These agents include *Leptospira sp., Campylobacter fetus* and viruses such as infectious bovine rhinotracheitis (IBR) and bovine virus diarrhea (BVD). Maintenance in the cow of a high level of immunity to these agents during pregnancy can insure protection of the fetus. In particular, vaccines against BVD and IBR viruses can establish protective immunity throughout gestation.

An appropriate vaccination regimen prior to breeding is required to establish this protective immunity. This can be achieved with a single dose of certain modified live virus vaccines, but those vaccines must be administered at least 30 days prior to breeding to avoid interference with conception. We have evaluated an oil-adjuvanted inactivated virus vaccine in cattle with differing immunological histories. Two doses of the vaccine administered 30 days apart to serologically negative animals induced appreciable levels of BVD and IBR anti-viral antibodies with persisting titers throughout gestation. In other experiments a single dose of the vaccine was administered to: (1) animals given two doses of the vaccine several months earlier, (2) animals previously vaccinated with other inactivated virus vaccines, or (3) animals previously vaccinated with modified live virus vaccine. The vaccine consistently induced marked anamnestic responses in these animals. Not only did mean titers rise, but a vast majority of individual animals responded. This contrasts with efforts to boost titers with modified live virus vaccines where the effect may be erratic among animals. The safety and efficacy of selected inactivated viral vaccines argues for their use in prebreeding immunization of beef cows.

Introduction

A number of infectious agents are potential threats to the fetus of a pregnant cow, often resulting in congenital defects or abortion. These agents include *Leptospira* sp., *Campylobacter fetus* and viruses such as infectious bovine rhinotracheitis (IBR) and bovine virus diarrhea (BVD). Maintenance in the cow of a high level of immunity to these agents during pregnancy can insure protection of the fetus. In particular, vaccines against BVD and IBR viruses can establish protective immunity throughout gestation. This immunity can have at least three important effects: (1) to enhance reproductive performance, (2) to protect the fetus during gestation and (3) to increase availability of colostral antibodies to the newborn calf.

Immunization can be an important component of management practices. However, there are reports that vaccination does not always prevent viral effects on the fetus. This failure may be due in part to the use of vaccines or a vaccine protocol that does not maintain a protective level of immunity throughout gestation. Such a situation might be indicated by the observed level of antibodies in the sera of two-year-old cows vaccinated at 6-7 months of age with modified live virus vaccine (Table 1).

Table 1. Distribution of antibody titers among 83 two-year-old cows vaccinated at 6-7 months of age with modified live virus vaccine.

	Number of Sera		
Titer	**BVD-1**	**BVD-2**	**IBR**
<2	0	8	16
2	0	14	9
4	4	20	14
8	4	9	22
16	13	10	13
32	9	8	8
64	21	10	1
128	10	3	0
252	7	0	0
812	10	0	0
1024	2	0	0
2048	2	0	0
4096	1	0	0

It should be noted that there was extreme variability in antibody titers among the animals. A few animals had quite high titers, but there were many with minimal titers against the three viruses. One could assume that the latter are susceptible to viral infection. We report the results of experimentation utilizing several different viral vaccines for the immunization of cows.

Materials and Methods

Animals utilized in this experimentation were crossbred or Angus females resident at either the McNay or Rhodes research farms. Crossbred animals were raised on the farms. The Angus were purchased when approximately eight months of age and had a vaccination history.

The animals were bled and vaccinated as indicated in the individual experiments. All vaccines were purchased from commercial sources and included:

A. Bovishield, Pfizer. Modified live IBR and BVD viruses,
B. Vira Shield, Grand Laboratories. Inactivated viruses,
C. Cattlemaster 4, Pfizer. Modified live IBR and inactivated BVD viruses,

D. Elite 4, Boehringer Ingleheim. Inactivated viruses,
E. Triangle, Fort Dodge Laboratories. Inactivated viruses, and
F. Premier, Tech America. Inactivated viruses.

Vaccines were administered according to the manufacturers' recommendations. Sera were harvested and stored at –20°C until tested for antibodies with virus neutralization tests.

Results

A series of experiments were conducted and are reported as individual experiments with protocol and findings.

Experiment I. The 83 two-year-old cows included in Table 1 were randomly assigned to one of three groups with one group vaccinated with modified live virus vaccine (A), another group with an inactivated virus vaccine (B) and the third group left as unvaccinated controls. Sera obtained from these animals 19 days later were tested for antibodies to BVD and IBR viruses. Mean antibody titers increased dramatically in vaccinated groups of cows (Table 2).

Table 2. Serum antibody titers of vaccinated and non-vaccinated cows 19 days following administration of modified live or inactivated virus vaccines.

		Serum Antibody Levels		
	Group	BVD-1	BVD-2	IBR
Control				
	Mean Titer*	45.9*	8.8	6.9
	Range	4-4096	<2-2048	<2-32
MLV Vac**				
	Mean Titer	233.9	32.7	43.1
	Range	16-2048	4-512	8-256
OIV Vac***				
	Mean Titer	362.0	54.7	30.5
	Range	16-4096	16-1024	8-128

* Reciprocal of neutralizing dilution
** Modified live virus vaccine (A)
***Oil adjuvanted inactivated virus (B)

However, when responses of individual animals were reviewed, cows with minimal BVD antibody titers at the time of vaccination responded well to the inactivated virus vaccine with more restricted enhancement in animals with a high level of antibodies. The responses of animals receiving the modified live virus vaccine were more erratic with minimal responses resulting in some animals with low titers at the time of vaccination.

Experiment II. Forty-two Angus heifers that had a history of vaccination with modified live virus vaccine (A) at 6-7 months of age were bled at one year of age. BVD virus neutralization tests indicated that all animals were serologically positive. The animals were vaccinated with an inactivated virus vaccine (B), and the animals were bled for serum 21 days later and again one year later. Antibody levels are provided in Table 3.

Table 3. Serum antibody levels in cows (21 days, and one year following vaccination) with an oil-adjuvanted inactivated virus vaccine (B).

	Serum Antibody Levels		
Time	BVD-1	BVD-2	IBR
Prevaccination			
Mean Titer*	46.7*	12.8	1.4
Range	4-512	<2-256	<2-8
Postvaccination (21 days)			
Mean Titer	3104.2	494.6	106.2
Range	128-4096	2-4096	4-256
Postvaccination (one year)			
Mean Titer	252.5	63.1	19.0
Range	16-2048	16-512	4-128

*Reciprocal of neutralizing dilution

Marked increases in antibody titers were present at 21 days, and there was persistence of moderate levels of antibodies for one year. The distribution of titers among individual animals is shown in Figure 1 and indicates the relative uniformity of BVD antibody titers in these vaccinated animals.

Figure 1. Frequency distribution of antibody titers in sera of 40 two-year-old cows. These animals were vaccinated with modified live BVD virus vaccine (A) at 6-7 months of age and with inactivated virus vaccine (B) at one year of age.

Experiment III. Twenty head of heifer calves were vaccinated twice with a 30-day interval with a modified live IBR- inactivated BVD virus vaccine (C) at 5-6 months of age. These animals were bled and administered a booster dose of inactivated virus vaccine when 13 months of age.

They were bled again for serum three weeks later. Frequency distribution of antibody titers in individual animals against IBR, BVD-type 1 and BVD-type 2 viruses are shown in Figures 2, 3 and 4.

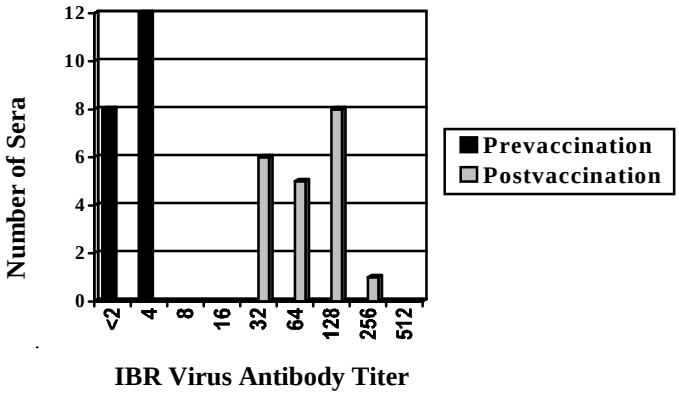

Figure 2. Frequency distribution of IBR virus antibody titers among 20 animals before and after secondary vaccination with an inactivated virus vaccine (B).

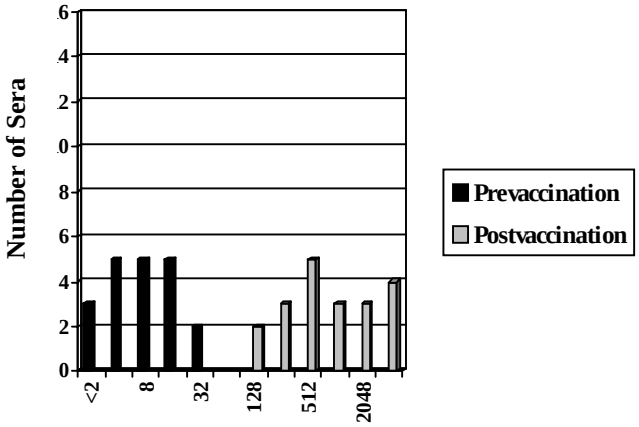

Figure 3. Frequency distribution of BVD type 1 virus antibody titers among 20 animals before and after secondary vaccination with an inactivated virus vaccine (B).

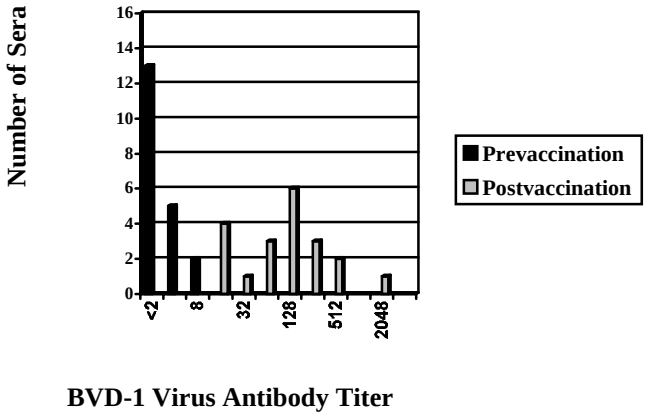

Figure 4. Frequency distribution of BVD type 2 virus antibody titers among 20 animals before and after secondary vaccination with an inactivated virus vaccine (B).

Experiment IV. Ninety-four heifer calves were vaccinated intranasally with a modified live IBR virus vaccine followed by two doses of inactivated IBR-BVD virus vaccine (D or E) with a 30-day interval. As yearlings, they were bled, vaccinated with an inactivated virus vaccine (B), and bled again three weeks later. Prevaccination and postvaccination antibody titers are provided in Table 4.

Table 4. Antibody responses of yearling heifers 21 days after booster vaccination with an inactivated virus vaccine (B).

	Serum Antibody Levels		
Time	BVD-1	BVD-2	IBR
Prevaccination			
Mean Titer*	3.3*	1.3	1.5
Range	<2-64	<2-4	<2-8
Postvaccination			
Mean Titer	278.2	16.3	40.8
Range	<2-4096	<2-256	4-256

*Reciprocal of neutralizing dilution

Experiment V. One hundred thirty yearling heifers that had not been previously vaccinated with BVD virus and were serologically negative were randomly assigned to one of four groups. The groups of animals were treated as follows: (1) Controls, no vaccination, (2) Vaccine B, (3) Vaccine E, and (4) Vaccine F. All vaccines were administered according to the manufacturers' directions with two vaccinations 30 days apart. The heifers were bled 60 days after primary immunization, bled and boosted with the same vaccine a year later, and bled again at the two-year point. Antibody levels to BVD virus are presented in Table 5.

Number f Sera

Table 5. BVD antibody levels at intervals over a two-year period in cattle vaccinated with inactivated virus vaccines. Animals were vaccinated at 12, 13, and 26 months of age.

	Serum BVD Virus Antibody Levels			
Age	Controls	Vaccine B	Vaccine E	Vaccine F
12 Months				
No.	27	32	39	32
Mean Titer	<2*	<2	<2	<2
14 Months				
No.	27	32	39	32
No. Positive	0	32	39	32
Mean Titer	<2	635	286	185
26 Months				
No.	25	28	34	23
No. Positive	2	28	34	21
Mean Titer	6**	55	27	10**
38 Months				
No. 16	15	19	12	
No. Positive	1	15	19	12
Mean Titer	16	234	89	26

* Reciprocal of neutralizing dilution
**Positive animals only

The number of animals declined over the period of experimentation due to culling. However, the results clearly demonstrated that Vaccine B would maintain good levels of BVD antibodies in these animals when administered on an annual basis.

Discussion

Protection of the bovine fetus from infection with IBR and BVD viruses is dependent on the maintenance of a minimum level of immunity in the cow. The question that arises is whether or not this immunity can be maintained throughout gestation with selected vaccines and vaccination protocol. Results of serologic testing of cattle indicated that levels of antibodies are markedly variant depending on the type of vaccine utilized and the time of administration. The findings also confirm the need for annual vaccination of cows in a breeding herd. We suggest that this vaccination be administered two to four weeks prior to breeding so that strong immunity is present in these animals early in the gestation period. If modified live virus vaccines are used a four-week interval is recommended due to the recognized ability of the viruses to infect the ovary and interfere with conception.

The findings of this experimentation support the usage of an oil adjuvanted inactivated virus vaccine (B). This vaccine: (1) will induce good humoral responses in naïve animals when two doses are administered 30 days apart, (2) will induce excellent secondary responses in animals previously primed with modified live or inactivated virus vaccines, (3) will broaden the response to BVD viruses because it contains both type 1 and type 2 viruses, and (4) because the viruses are inactivated, can be safely utilized at any time.

Acknowledgment

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