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Transfer of Antibodies against Viruses of Calf Diarrhea from Cows to Their Offspring via Colostrum

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ABSTRACT. Serum and lacteal secretion of cows and neonatal calf serum were examined for antibody titers against bovine rotavirus, bovine coronavirus, and bovine viral diarrhea-mucosal disease virus and immunoglobulin concentrations after inoculation with inactivated viruses during pregnancy. The booster effect was slight. Correlation was observed between maternal serum, lacteal and neonatal serum antibody titers as well as duration of the antibody titer in lacteal secretion. The biological half lives of antibody titers in calf serum were about 22.0 days for rotavirus and 20.8 days for coronavirus.—**KEY WORDS:** antibody transfer, colostrum, viral calf diarrhea.

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For prevention of neonatal calf diarrhea many attempts have been made with vaccination to the dam during pregnancy in order to stimulate lacteal secretion of antibodies against etiological agents. As most of cows in the field possess considerable levels of serum antibody titer against rotavirus and coronavirus, it is doubtful whether vaccinations with attenuated live viruses would take effectually in these cows [4, 7, 10, 11]. The application of oil adjuvant has been reported to be effective either for the live vaccine [2, 2, 11] or for the inactivated vaccine [9, 12, 13, 14]. Its routine use may be often not practical because of reluctance of clients, especially in dairy cows. There have been hitherto few reports about the efficacy of the inactivated vaccine without oil adjuvant [1]. As a prerequisite for the lacteal immunity, the present report describes the relationship among maternal serum, lacteal and neonatal serum antibody titers against three viruses causative of calf diarrhea.

Bovine rotavirus strain Shimane 1 was cultured in MA104 cells with trypsin, bovine

coronavirus strain Kakegawa and bovine viral diarrhea-mucosal disease (BVD-MD) virus strain Tokachi were in BEK-1 cells. Rotavirus had a titer of $10^{6.3}$ TCID₅₀/ml, coronavirus $10^{7.2}$ TCID₅₀/ml, and BVD-MD virus $10^{5.5}$ TCID₅₀/ml. For vaccine preparation rotavirus and coronavirus were concentrated to 1/10 volume by the polyethylene glycol method [6], and BVD-MD virus was by the Zn(OH)₂ method [8]. Each virus increased 10 times or more in titer. Viruses were adsorbed to alum gel adjuvant by mixing 90 volume of virus suspension, 5 volume of 16% tribasic sodium phosphate and 5 volume of 10% aluminum chloride, then inactivated with 0.5% formalin at 4°C.

Six pregnant Holstein-Friesians were used. Most of them possessed preexisting serum antibody titers to rotavirus and coronavirus due to natural infection. In order to obtain high titer of maternal antibody, the cows were vaccinated with any of the inactivated viruses. Repeated inoculations with 10 ml each were given to buttock intramuscularly, with irregular subcutaneous inoculations in the

Table 1. Highest antibody titer and duration^{a)}

Antibody against	Cow No.	Maternal serum		Colostrum	Neonatal serum	Duration of titer in whey until ^{b)}	
		Ante-vacc	Post-vacc			1/2 logx	Negative
Rotavirus (HI)	1	*c)	16 ^{d)}	128	64	59	7
	2	64	128	512	512	61	14
	6	32	32	32	32	31	1.5
	4	32	32	256	32	47	7
	8	32	64	512	256	38	7
	15 ^{e)}	— ^{f)}	64	1024	512	50	14
Coronavirus (HI)	1	*	32	128	128	45	2.5
	2	16	64	128	128	42	2.5
	6	32	128	256	256	39	2.5
	4	8	8	64	32	36	2
	8	32	32	64	128	37	2
	15	—	32	128	128	46	7
BVD-MD virus (NT)	1	*	<2	2	2	0	0
	2	<2	4	16	16	30	2
	6	<2	<2	4	2	0	0.5
	4	<2	64	256	256	50	7
	8	4	64	128	128	42	7
	15	—	<2	2	2	0	0

a) Normal distribution was confirmed in each population.

b) The time required for the antibody to drop to 1/2 logx (in hr) or to tentative negative level (in days). x =the initial highest titer in colostrum.

c) Not vaccinated.

d) Titers expressed as reciprocal of serum dilution.

e) Homologous to vaccine virus.

f) The sample lost accidentally.

Table 2. Summary of correlation

Correlation ^{a)} between	Rotavirus		Coronavirus		BVD-MD virus	
	r	Signif ^{b)}	r	Signif	r	Signif
Highest antibody titers						
Maternal serum—Lacteal	0.785	—	0.842	*	0.864	*
Lacteal—Neonatal serum	0.857	*	0.830	*	0.954	*
Maternal serum—Neonatal serum	0.771	—	0.914	*	0.985	*
Lacteal titer and duration ^{c)}						
Highest—1/2 logx	0.520	—	0.585	—	0.520	—
Highest—Negative	0.871	*	0.771	—	0.985	*

a) Spearman's rank correlation, $n=6$.

b) Significance at 5% level.

c) See footnote of Table 1.

mammary lymph node region. A total of 3–10 inoculations were repeated until 2–3 weeks before the calving. One animal was not vaccinated. After parturition the calves

were allowed to remain with the dam to suck colostrum freely for 5 days. Milk and blood samples of each cow and calf were collected at intervals from 0 hr to 12 weeks after

parturition to determine antibody titers. Concentrations of immunoglobulin classes were determined by the method of Mancini *et al.* [5].

General pattern of changing time course in maternal serum, lacteal and neonatal serum antibodies seemed to have the similar tendency each in all the experimental animals, regardless of the virus species used for vaccination or caused natural infection. No vaccination seemed to exert a detectable influence on the concentration of any class of immunoglobulins in cow's serum, whey, or calf's serum (Data not shown).

As shown in Table 1, the booster effect was unexpectedly slight to homologous antibody titers in spite of repeated vaccinations. Table 2 showed correlations among the highest antibody titers in individual cow's serum, colostrum and its offspring serum. Correlation was also found in lacteal secretion between the initial highest titer and the duration of antibody until negative level, but not its duration until $1/2$ times $\log_{10}$ of the initial highest titer. The lack of correlation in the latter coincided with the changes of lacteal secretion from colostrum to normal milk around 48 hr after parturition. This change was also confirmed by the decrease of IgG₁. Thus, in principle, the boosted elevation of maternal serum antibody titer may promise higher titer and longer duration of the lacteal antibody. Further improvement should be made, however, for practical application of the booster-vaccination. Factors which may have favorable influence on this method are, besides oil adjuvant, considered to be the adoption of levamisole, more purified viruses in higher titer, route of mammary inoculation, and successive annual vaccination, etc.

In the calf serum the biological half lives of antibody titers were calculated as 22.0 ± 4.3 days for rotavirus and 20.8 ± 2.8 days for coronavirus. For BVD-MD virus no reliable result was obtained because of the low prevalence of antibody-positive serum. For the

prevention of neonatal calf diarrhea, antibody continuously present in the alimentary tract would be more important than serum antibody in calves. Other methods to maintain the protective immunoglobulins in gut lumen in larger amount and for longer period would be also essential.

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要 約

子牛下痢症ウイルス抗体の初乳を介する母子移行（短報）：村上敏明・平野紀夫・井上 玲・千歳健一・土屋耕太郎・小野勝彦・内藤善久¹⁾（岩手大学農学部家畜微生物学教室，¹⁾家畜内科学教室）——それぞれの不活化ウイルスを接種した母牛の血清・乳汁とその子牛血清について，牛ロタウイルス，牛コロナウイルス，牛ウイルス性下痢・粘膜病ウイルスに対する抗体価と免疫グロブリン濃度を測定した。ワクチンの効果は軽微であった。母牛血清，乳汁，子牛血清の抗体価および乳汁抗体価の持続期間の間に相関がみられた。子牛血中抗体の半減期はロタウイルスで約22.0日，コロナウイルスで約20.8日であった。