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Research Article

Effects of IgY Supplementation on Hanwoo Calves Fed with High Quality Roughage

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양질 조사료 급여에 따른 한우 송아지의 IgY 처리효과

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ABSTRACT

This study was conducted to examine the effect of IgY supplementation on growth performance, blood metabolism, and disease occurrence in the weaned calves at 3 or 4 month of age. Average daily gain (ADG) and feed intakes were not affected by IgY supplementation, regardless of weaning months. White blood cell (WBC) count of the control group was higher in the final stage than in the initial stage ($p<0.05$), while that of the IgY supplemented group was lower in the final stage compared to the initial stage ($p<0.05$). regardless of treatments. Hematocrit (HCT) and red blood cell (RBC) counts were lower in the final stage than in the initial stage ($p<0.05$), but mean corpuscular volume (MCV) and mean corpuscular hemoglobin (MCH) counts were higher in the final stage than in the initial stage, regardless of treatments. In the control group, concentrations of albumin and globulin were higher in the final stage compared to the initial stage in the weaned calves at 3 month of age ($p<0.05$), and concentration of blood urea nitrogen (BUN) was increased in the IgY supplemented group. In the control group, concentrations of aspartate aminotransferase (AST) and gamma (γ)-glutamyl transferase (GGT) were higher in the final stage compared to the initial stage ($p<0.05$). In contrast, concentrations of aspartate aminotransferase (AST) and gamma(γ)-glutamyl transferase (GGT) were lower in the final stage compared to the initial stage for the IgY supplemented group. A diarrhea calf was only found in the control group. Manure score was higher in the control group compared to IgY supplemented group ($p<0.05$). Thus, these results indicates that IgY supplementation had positive effects on some blood metabolites, fecal condition score and diarrhea without negative effect on growth performance of the weaned Hanwoo calves.
(**Key words :** IgY, Hanwoo calves, Blood metabolism, Manure score)

Ⅰ. INTRODUCTION

Control and prevention of calf disease is a critical management in Hanwoo (Korean native cattle) production operations. Many calves were died from viral diarrhea and respiratory disease. Especially, diarrhea is the major disease occurring in Hanwoo calf. The mortality rate caused by diarrhea is approximately 25% in Korea.

Unlike primates and rodents, newbornly calf must depend on passive immunity through colostrum feeding to strengthen level of immunity (Osburn et al., 1982) because the immunoglobulin is not passed from maternal placenta to the fetus blood. According to the study by Arthington et al. (2000), newborn calf old should maintain blood lgG concentration over 10 mg/ml to acquire immunity against diseases. However, a new born calf goes through decrease in blood lgG concentration leading the level of immunity decreases as time flows. As a result, various methods such

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as frozen colostrum, injection of lgG fluid, dry colostrum, fermented colostrum, and egg yolk antibody (lgY) are in use for preventing disease by enhancing calf immunity (Jung et al., 2009).

IgY is an antigen-specific material which is the major antibody in bird. It is also found in the high concentration the egg yolk (Rose et al., 1974). IgY derived from egg has a low cross reaction related to interspecific diversity, and a high possibility for commercial production compared to others. In addition IgY has been used for prevention and treatment of infectious disease (Kovacs-Nolan and Mine, 2004; Lee et al., 2004; Shin et al., 2000; Woo et al., 1998), and researches reported the defense effect of IgY against disease (Kim et al., 2008, Bertolott-Ciarlet et al., 2003; Ikemori et al., 1997; Kuroki et al., 1994).

Wiedemann et al. (1991) reported that piglet diarrhea was cured by the injection of lyophilized egg containing IgY. Osame et al. (1991) also found that neonatal calf diarrhea was prevented by IgY supplementation with colostrum. In addition, Lee et al. (2009) suggested that IgY could be effectively control proliferation of bovine rotavirus (BRV) and bovine coronavirus (BCV) according to immune specificity to some diarrheagenic virus. Several studies have been conducted to examine the effect of IgY supplementation on young calves before one month old. However, there is limited data to confirm the effect of IgY supplementation on weaned calves at 3 or 4 months old in Korea.

This study was conducted to examine the effect of lgY supplementation on growth performance, blood metabolism, and disease occurrence in the weaned Hanwoo calves at 3 or 4 month of age.

Ⅱ. MATERIALS AND METHODS

1. Calves, experimental design, and treatments

Twenty Hanwoo calves (average body weight 98.2±5.9 kg) were use in this trial. Hanwoo calves were fed for ad libitum intake the timothy hay and commercial concentrate without supplementation (Control), or supplemented IgY (1g/calf/day). Calves were kept under nursing barn with their mother cow. Experimental diets were offered twice daily (08:00 and 18:00h). All calves were allowed free access to fresh water.

Table 1. Chemical composition of experimental diets

Item	Concentrate	Timothy hay
Dry matter (%)	89.67±0.43	95.31±0.97
Crude protein (%)	17.56±0.24	8.20±0.12
Ether extract (%)	3.02±0.11	1.80±0.05
Crude fiber (%)	12.52±0.19	31.48±1.51
Crude ash (%)	9.59±0.09	7.20±0.25
Ca (%)	0.73±0.02	0.23±0.01
P (%)	0.66±0.01	0.19±0.01

2. Measurements and analyses

1) Average daily gain, dry matter intake, and feed conversion ratio

Feed intake was recorded daily by weighing offered to and refused by calves, and calves were weighted at the beginning and at the end of each experiment period for analyzing average daily gain (ADG), dry matter intake (DMI) and feed conversion ratio

2) Blood collection and analyses

Ten milliliters of blood was taken from the jugular vein, and then transfer into evacuated test tubes (Vacutainer, Becton 93 Dickinson Vacutainer Systems, Rutherford, NJ, USA) containing heparin (serum analysis) or EDTA (whole blood analysis) at the beginning and at end of each experiment period for analysis of blood metabolites. Tubes containing heparin were centrifuged at 3000×g for 15 min at 4℃. Total protein (TP), glucose, cholesterol, Mg, Ca, gamma(γ)-glutamyl transferase (GGT) and aspartate amino-transferase (AST) were analyzed using the Metabolic Profile Test (FDC-3500, Fuji, Japan). For analyzing complete blood count (CBC), tubes containing EDTA were maintained for 12 hours at 4℃. White blood cell (WBC), neutrophil (NE), lymphocyte (LY), monocyte (MO), eosinophil (EO), basophil (BA), red blood cell (RBC), hemoglobin (Hb), hemoglobin (MCH), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), red cell distribution width (RDW), platelet (PLT) and mean platelet volume (MPV) were analyzed using the FORCYTE (FC-1217, Oxford science InC., USA).

3) Examination of feces condition score

Fecal condition score was measured using method invented by Larson et al. (1977) every Friday at 5:00 pm (Table 2).

Table 2. Fecal fluidity score of Hanwoo calves

Score	Status	References
1	Normal	Normal fecal consistency
2	Soft	Slightly liquid feces
3	Runny	Moderately liquid
4	Watery	Severely liquid feces

3. Statistical analysis

The data from the experiment were analyzed using T-tests using SAS (1999). A $p<0.05$ was considered to be statistically significant.

Ⅲ. RESULTS AND DISCUSSION

Average daily gain (ADG) was not affected by IgY supplementation, regardless of weaning month (Table 3). In the weaned calves at 4 month of age, the average daily gain (ADG) of calves IgY supplemented group was increased by 7% compared to the control (0.69 vs 0.74kg). IgY supplementation had no effect on feeds intake, while feed conversion ratio was increased by IgY supplementation (4.52 vs 4.30).

Hong et al. (2001) reported that lgY contain 41% of crude protein and 1~4% of 18 kinds of amino acid. We expected that the average daily gain (ADG) of calf was improved by IgY supplementation. However, IgY had a small impact on the average daily gain (ADG) and feed intake of Hanwoo calf in this study. This result might be due to an adequate supply related to enough feed intake, regardless of treatments. Jung et al. (2009) reported that IgY supplementation had no effects on average daily gain (ADG) and dry matter intake (DMI) of Holstein calves. However, Ozpinar et al. (1996), they found that IgY supplementation had a positive effect on average daily gain (ADG) of Holstein calves, according to the dosage of IgY (2, 4 and 8g, respectively). The result of this study was consistant. Thus, these results showed that IgY supplementation did not have effects on average daily gain (ADG) and feed intake of the weaned calves.

In the weaned calves at 3 month of age, the white blood cell (WBC) count of control group was higher in the final

Table 3. Effect of IgY supplementation on growth performance of Hanwoo calves

Item	Control	Treatment	Pr > ltl
3 mo. of age			
Initial body weight (kg)	94.8±3.95	92.8±3.30	0.47
Final body weight (kg)	153.8±4.57	151.5±4.12	0.49
Average daily gain (kg)	0.72±0.04	0.72±0.03	0.83
Feed intake (DM kg/head/day)			
Concentrate	1.90±0.00	1.98±0.00	
Timothy	1.19±0.07	1.22±0.12	
Feed conversion ratio	4.30±0.17	4.48±0.23	0.28
4 mo. of age			
Initial body weight (kg)	103.4±3.05	104.8±2.22	0.48
Final body weight (kg)	160.0±4.6	165.0±4.7	0.15
Average daily gain (kg)	0.69±0.04	0.74±0.03	0.11
Feed intake (DM kg/head/day)			
Concentrate	1.90±0.00	1.98±0.00	
Timothy	1.23±0.12	1.20±0.19	
Feed conversion ratio	4.52±0.12	4.30±0.35	0.08

stage than in the initial stage (Table 4, $p<0.05$), while that of IgY supplemented group was lower in the final stage compared to the initial stage ($p<0.05$). However, neutrophils (NE), nymphocytes (LY), monocytes (MO), eosinophils (EO) and basophils (BA) counts were lower in final stage like white blood cell (WBC) count but which is not significantly difference.

In the weaned calves at 4 months old, CON group showed higher counts of WBC, NE, LY, MO, EO and BA in the final stage compared to the initial stage, showed lower counts of while the IgY supplemented group in the final stage.

These results implied that IgY supplementation decreased white blood cell (WBC), neutrophils (NE), nymphocytes (LY), monocytes (MO), eosinophils (EO) and basophils (BA) counts of the weaned calves, regardless of weaning age.

The leukocyte count increased in the control group, which is within the normal range because of the incidence of diarrhea calf. Ryu et al. (1997) reported that leukocyte count increased due to factors such as infecting pathogen, stress, and injury. Thus, these result indicated that IgY supplementation could be an effective way of reducing white blood cell (WBC) count to stabilize immune system according to the elimination of antigen in the body of calf.

In the weaned calves at 3 month of age, hematocrit (HCT) and red blood cells (RBC) counts were lower in the final stage than in the initial stage, but mean corpuscular volume (MCV) and mean corpuscular hemoglobin (MCH) counts were higher in the final stage compared to the initial stage, regardless of treatments. Hemoglobin (Hb) and mean corpuscular hemoglobin concentration (MCHC) counts tended to be increased in the control group, while these counts tended to be decreased in the IgY supplemmented group.

In the weaned calves at 4 month of age, hematocrit (HCT), red blood cells (RBC) and ean corpuscular hemoglobin (MCH) counts showed similar tendency compared to the weaned calves at 3 month of age. Hemoglobin (Hb) and and mean corpuscular hemoglobin concentration (MCHC) counts tended to be higher in the final stage compared to the initial stage, regardless of treatments. In case of control group, red blood cells (RBC) count was higher in the final stage than in the initial stage ($p<0.05$), while red blood cells (RBC) count was decreased in IgY treated group by supplementation of IgY ($p<0.05$).

The recommendable red blood cells (RBC) count is below

Table 4. Effect of IgY supplementation on blood leukocytes of Hanwoo calves

Item	Control			Treatment			Contrast	
	Initial (0 d)	Final (82 d)	Pr > ltl	Initial (0 d)	Final (82 d)	Pr > ltl	Control vs Treatment	
3 mo. of age								
WBC[1)] (K/ul)	7.78±3.45	11.45±11.94	0.03	8.32±2.05	5.62±0.64	0.05	0.59	0.56
NE[2)] (K/ul)	2.38±1.57	3.85± 3.74	0.13	2.95±2.38	2.25±0.14	0.01	0.7	0.61
LY[3)] (K/ul)	3.73±2.45	6.16± 6.88	0.06	3.77±0.97	2.88±0.52	0.22	0.98	0.57
MO[4)] (K/ul)	0.94±2.18	1.13± 0.92	0.20	1.54±0.52	0.41±0.05	0.01	0.24	0.37
EO[5)] (K/ul)	0.08±0.10	0.20± 0.27	0.15	0.05±0.05	0.07±0.01	0.01	0.61	0.55
BA[6)] (K/ul)	0.05±0.10	0.09± 0.15	0.35	0.01±0.01	0.02±0.05	0.09	0.41	0.57
4 mo. of age								
WBC (K/ul)	8.11±1.89	9.96± 4.92	0.11	8.41±1.91	4.97±1.07	0.23	0.82	0.16
NE (K/ul)	1.54±2.41	1.94± 0.95	0.09	2.15±1.16	1.42±0.36	0.10	0.36	0.41
LY (K/ul)	5.22±1.64	6.10± 2.67	0.38	5.10±0.92	2.83±0.73	0.98	0.9	0.12
MO (K/ul)	1.32±0.25	1.83± 1.30	0.01	1.13±0.23	0.65±0.23	0.71	0.29	0.19
EO (K/ul)	0.03±0.02	0.08± 0.06	0.08	0.03±0.03	0.05±0.05	0.18	0.65	0.56
BA (K/ul)	0.01±0.00	0.02± 0.01	0.01	0.01±0.01	0.02±0.02	0.01	0.41	0.92

[1)] WBC: white blood cell; [2)] NE: neutrophils; [3)] LY: lymphocytes; [4)] MO: monocytes; [5)] EO: eosinophils; [6)] BA: basophils.

11.0 M/ul in Hanwoo calves under 12 months old (Cho, 2010), red blood cells (RBC) count was affected by various factors such as dehydration, energy level of feed, etc (Ryu and Lee, 1997). Red blood cells (RBC) count could be reduced by the dilution effect of blood related to increasing age and water intake. Although water intake was not examined in the present study, we have never excluded that the possibility that red blood cells (RBC) count might be reduced by increased water intake according to the supplementation of IgY. Consequently, more research is needed.

In the weaned calves at 3 months of age, concentrations of glucose, cholesterol and total protein were similar between treatments, regardless of blood collection time (Table 6). Concentrations of albumin and globulin were higher in the final stage than in the initial stage in the control group(p<0.05). The result was considered due to antibody production caused by infecting pathogen and increased LY count (Table 4) as the antibody-formation factors. Concentration of BUN was lower in the final stage than in the initial stage in the control group (p<0.05), but the higher concentration of blood urea nitrogen (BUN) was observed in the final stage in the IgY supplemented group (p<0.05). Increased blood urea nitrogen (BUN) concentration in the IgY supplemented group was related to the addition of IgY protein. In addition, this result was consistent with Jung (2009)' result which found an increase in blood urea nitrogen (BUN concentration when IgY was fed to Holstein calves. In the control group, concentrations of aspartate aminotransferase (AST) and gamma(γ)-glutamyl transferase (GGT) were higher in the final stage compared to the initial stage (p<0.05). In contrast, concentrations of aspartate aminotransferase (AST) and gamma(γ)-glutamyl transferase (GGT) were lower in the IgY supplemented group.

In the weaned calves at 4 month of age, aspartate aminotransferase (AST) concentration was lower in the final stage compared to the initial stage, in both control and IgY supplemented group.

Generally, aspartate aminotransferase (AST) and gamma (γ)-glutamyl transferase (GGT) have been used as indicator for a liver-function examination, for example, an increase in AST count indicates damage in body tissue or liver. Aspartate aminotransferase (AST) is type of enzyme existing in cytoplasm, and its count in the blood can be increased

Table 5. Effect of IgY supplementation on blood erythrocytes of Hanwoo calves

Item	Control			Treatment			Contrast	
	Initial (0 d)	Final (82 d)	Pr > ltl	Initial (0 d)	Final (82 d)	Pr > ltl	Control vs Treatment	
3 mo. of age								
HCT[1)] (%)	35.78±2.20	34.65±3.04	0.55	31.30± 7.70	27.70±4.40	0.32	0.28	0.15
RBC[2)] (M/uL)	12.34±0.94	11.19±0.22	0.02	10.92± 1.48	9.79±0.95	0.40	0.12	0.15
Hb[3)] (g/dL)	11.92±0.96	11.30±1.13	0.57	11.18± 2.30	11.33±2.30	0.88	0.53	0.99
MCV[4)] (fL)	29.16±3.23	31.05±3.32	0.82	28.60± 5.56	33.43±2.70	0.16	0.85	0.44
MCH[5)] (Pg)	9.70±0.96	10.15±1.20	0.64	10.48± 2.95	12.67±1.00	0.11	0.59	0.08
MCHC[6)] (g/dL)	33.32±2.09	32.60±0.42	0.01	36.40± 7.54	35.50±3.52	0.14	0.48	0.35
4 mo. of age								
HCT (%)	37.13±4.99	23.80±1.47	0.03	29.38±10.72	25.30±3.82	0.06	0.24	0.56
RBC (M/uL)	12.01±1.85	8.06±0.48	0.03	9.88± 2.95	7.97±0.70	0.02	0.25	0.87
Hb (g/dL)	12.15±1.50	12.30±1.74	0.82	10.98± 2.00	12.80±1.41	0.48	0.38	0.76
MCV (fL)	30.86±2.57	28.57±2.57	0.94	29.30± 2.26	31.70±1.98	0.80	0.39	0.25
MCH (Pg)	10.10±0.65	15.27±1.55	0.17	11.78± 3.74	16.05±0.35	0.01	0.44	0.55
MCHC (g/dL)	32.78±0.83	51.50±4.16	0.01	22.90±18.10	50.75±2.05	0.01	0.45	0.83

[1)] HCT: hematocrit; [2)] RBC: red blood cells; [3)] Hb: hemoglobin; [4)] MCV: mean corpuscular volume; [5)] MCH: mean corpuscular hemoglobin; [6)] MCHC: mean corpuscular hemoglobin concentration.

Table 6. Effect of IgY supplementation on blood metabolites concentration of Hanwoo calves

Item	Control			Treatment			Contrast	
	Initial (0 d)	Final (82 d)	Pr > ltl	Initial (0 d)	Final (82 d)	Pr > ltl	Control vs Treatment	
3 mo. of age								
Glu[1)] (mg/dl)	90.33±12.06	95.20±25.51	0.20	96.33±35.73	91.75±17.10	0.17	0.8	0.82
Chol[2)] (mg/dl)	122.00±15.10	118.80± 9.44	0.40	116.30±12.22	104.50±15.59	0.73	0.64	0.13
TP[3)] (g/dl)	5.90± 0.10	6.20± 0.24	0.46	5.87± 0.21	5.98± 0.22	0.92	0.84	0.15
Alb[4)] (g/dl)	2.83± 0.06	3.00± 0.36	0.01	2.77± 0.21	2.83± 0.13	0.27	0.62	0.78
Glo[5)] (g/dl)	3.07± 0.06	3.20± 0.22	0.03	3.10± 0.10	3.15± 0.13	0.91	0.81	0.02
BUN[6)] (mg/dl)	9.67± 2.08	9.60± 0.55	0.02	9.00± 2.00	10.25± 1.50	0.35	0.71	0.39
Ca (mg/dl)	12.27± 1.00	11.34± 0.74	0.51	11.50± 0.61	11.70± 0.32	0.86	0.32	0.4
Mg (mg/dl)	2.41± 0.11	2.32± 0.30	0.75	2.19± 0.33	2.00± 0.23	0.41	0.33	0.13
AST[7)] (u/ℓ)	79.33± 8.02	115.60±49.47	0.01	128.70±64.59	98.50±45.76	0.53	0.32	0.61
GGT[8)] (u/ℓ)	25.33± 6.11	30.20±10.76	0.31	31.33±14.64	24.25±27.22	0.30	0.55	0.66
4 mo. of age								
Glu[1)] (mg/dl)	97.00± 5.00	94.00±11.17	0.16	101.30± 9.45	97.50± 4.12	0.16	0.82	0.58
Chol[2)] (mg/dl)	123.70± 9.29	126.00±12.75	0.57	127.30±23.59	117.00±14.99	0.35	0.81	0.4
TP[3)] (g/dl)	6.03± 0.25	6.78± 0.58	0.18	6.00± 0.10	6.10± 0.29	0.12	0.81	0.15
Alb[4)] (g/dl)	2.93± 0.21	2.90± 0.32	0.38	2.87± 0.06	2.95± 0.13	0.25	0.62	0.39
Glo[5)] (g/dl)	3.10± 0.20	3.88± 0.47	0.18	3.13± 0.12	3.15± 0.17	0.84	0.64	0.7
BUN[6)] (mg/dl)	11.00± 1.00	10.25± 2.75	0.18	11.33± 1.15	11.25± 0.96	0.69	0.72	0.52
Ca (mg/dl)	11.93± 0.51	12.30± 0.84	0.34	10.27± 1.35	11.53± 0.34	0.18	0.14	0.14
Mg (mg/dl)	2.62± 0.13	2.53± 0.17	0.41	2.54± 0.13	2.55± 0.33	0.85	0.48	0.19
AST[7)] (u/ℓ)	92.67± 8.50	82.50±10.34	0.66	99.33± 5.13	89.50±25.17	0.02	0.31	0.63
GGT[8)] (u/ℓ)	24.67± 1.15	23.50± 2.52	0.26	26.00± 1.00	25.43± 2.64	0.31	0.21	0.18

[1)] Glu: glucose, [2)] Chol: cholesterol, [3)] TP: total protein, [4)] Alb: albumin, [5)] Glo: globulin, [6)] BUN: blood urea nitrogen.
[7)] AST: aspartate aminotransferase [8)] GGT: amma (γ)-glutamyl transferase.

by an extracellular efflux of aspartate aminotransferase (AST) according to an increase in cell membrane permeability when cell is damaged by some cause (Kim, 2009; Kim et al, 2012). Gamma(γ)-glutamyl transferase (GGT) is also sort of enzyme utilized for checking liver-function. Its count can be increased when animal experience bile-flow disorders, dyshepatia or hypohepatia (Kim, 2009; Kim et al, 2012).

These results implied that IgY supplementation did not have an effect on blood metabolites related to the liver function of the weaned calves. Meanwhile, the increase of aspartate aminotransferase (AST) and gamma(γ)-glutamyl transferase (GGT) concentration might be due to the transient hypohepatia related to the diarrhea treatment of a weaned calf at 3 month of age in the control group.

The result of this study indicated that IgY supplementation did not effect on blood metabolism of Hanwoo calves.

During the whole experimental period, respiratory disease was not found (Table 7), while a diarrhea was in the control group. Fecal condition score of calves was from 1 to 2 (normal condition). Similar fecal condition score was observed between treatments June to July, while fecal condition score was higher in the control group compared to in the IgY supplemented group in August ($p<0.05$). It could be explained by the incidence of diarrhea calf in the control group.

In this study, the IgY supplemented group showed lower diarrhea occurrence compared to the control group. This study indicated that IgY diminished antigens which trigger

Table 7. Effect of IgY supplementation on disease occurrence and fecal fluidity score in Hanwoo calves

Item	Months	Control	Treatment	Pr > |t|
Respiratory	June	–	–	–
	July	–	–	–
	August	–	–	–
Diarrhea	June	–	–	–
	July	–	–	–
	August	1	–	–
Fecal fluidity score	June	1.84±0.78	1.69±0.52	0.34
	July	1.72±0.52	1.62±0.58	0.35
	August	2.05±0.51	1.75±0.47	0.03

diarrhea such as virus or *E. coli* according to the antigen-antibody reaction with them. This finding was agreed withe the previous studies (Kim et al., 2008; Bertolotti-Ciarlet et al, 2003; Ikemori, 1997). However, This study might not conclude that supplementation of IgY supplemention has a positive effect on reduction of diarrhea occurrence in the weaned calves owing to limited number of experimental animal. Therefore, more research is needed to examine how IgY affect diarrhea occurrence in a large number of calves.

Ⅳ. CONCLUSION

Thise study indicates that IgY supplementation resulted in similar the growth performance of Hanwoo calves, regardless of weaning months. These results suggested that IgY supplementation had positive effects on some blood metabolites, fecal condition score and diarrhea without negative effects on growth performance of Hanwoo calves.

Ⅴ. REFERENCES

AOAC. 1990. Official method of analysis (15th Ed.). Association of official analytical chemists, Washington, D. C.

Arthington, J.D., Cattell, M.B., Quigley, J.D., McCoy, G.C. and Hurley, W.L. 2000. Passive IgG transfer in newborn calves fed colostrum or spray-dried serum protein alone or as a supplement to colostrum of varying quality. Journal of Dairy Science. 83(12):2834-2838.

Bertolotti-Ciarlet, A., Ciarlet, M., Crawford, S.E., Conner, M.E. and Estes, M.K. 2003. Immunogenicity and protective efficacy of rotavirus 2/6-virus-like particles produced by a dual baculovirus expression vector and administered intra- muscularly, intranasally, or orally to mice. Vaccine. 21:3885-3900.

Cho, H.U. 2010. Hematological and biochemical analysis of Korean indigenous cattle according to the ages. M.S. thesis. Chonbuk National University. Chonbuk. Korea.

Hong, J.W., Kim, I.H., Kwon, O.S., Lee, S.H. and Kim, J.W. 2001. Effects of Egg Yolk Antibodies to Replace Antibiotic in Segregated Early-Weaned Pigs. Journal of Animal Science and Technology. (Kor.) 43(2):177-184.

Ikemori, Y., Ohta, M., Umeda, K., Icatlo, F.C., Kurok, M., Yokoyama, H. and Kodama, Y. 1997. Passive protection of neonatal calves against bovine coronavirus-induced diarrhea by administration of egg yolk or colostrum antibody powder. Veterinary Microbiology. 58(2-4):105-111.

Jung, H.S., Jung, K.K. and Jang, I.S. 2009. Effect of Immunoglobulin Y on Growth Performance and Blood Immunological Parameters in Holstein Calves. Journal of Animal Science and Technology. (Kor.) 51(4):321-328.

Kim, D.S., Lee, T.J., Kang, J.H., Kim, J.H., Lee, J.H., Ma, S.H., Kim, S.Y., Kim, H.M. and Shin, S.M. 2008. Immunogenicity and safety of a pentavalent human-bovine (WC3) reassortant rotavirus vaccine in healthy infants in Korea. Pediatric Infectious Disease Journal. 27:177-178.

Kim, K.A. 2009. Understanding and application of liver function tests. The Korean Journal of Medicine. 76(2):163~168.

Kim, S.K. 2012. Studies on Optimal Rearing Density and Bedding Materials Thickness for Producing of Environmental-Friendly Hanwoo. Master Degree thesis, Kangwon national University, Chuncheon, Kor.

Kovacs-Nolan, J. and Mine, Y. 2004. Avian egg antibodies: basic and potential applications. Avian and Poultry Biology Reviews. 15:25-46.

Kuroki, M., Ohta, Y., Ikemori, Y., Peralta, R.C., Yokoyama, H. and

Kodama, Y. 1994. Passive protection against bovine rotavirus in calves by specific immunoglobulins from chicken egg yolk. Archives of Virology. 138:143-148.

Larson, L.L., Owen, F.G., Albright, J.L., Appleman, R.D., Lamb, R. C. and Muller, L.D. 1977. Guidelines toward more uniformity in measuring and reporting calf experimental data. Journal of Dairy Science. 60:989-992.

Lee, H.R. 2004. Clinical Studies on Hygienic Control for Prevention of Calf Diarrhea. Ph.D. thesis. Konkuk University. Seoul. Korea.

Lee, S., Woo, S.E., Lee, S.R. and Kim, J.W. 2009. Immuno-specificity of Egg Yolk Antibodies against Bovine Rotavirus and Bovine Coronavirus causing Calf Diarrhea. Journal of Animal Science and Technology. (Kor.) 51(5):407-412.

Osame, S., Ichojje, S., Ohata, C., Watanabe, W. and Goto, H. 1991. Efficacy of colostral immunoglobulins for therapeutic and preventive treatments of calf diarrhea. The Japanese Journal of Veterinary Science. 53(1):87-91.

Osburn, B.I., MacLachlan, N.T. and Terell, T.J. 1982. Ontogeny of the immune system. Journal of the American Veterinary Medical Association 181, 1049-1052.

Ozpinar, H., Erhard, M.H., Aytug, N., Ozpinar, A., Baklaci, C. Krarmuptuoglu, S., Hofmann, A. and Losch, U. 1996. Dose-dependent effects of specific egg-yolk antibodies on diarrhea of newborn calves. Preventive Veterinary Medicine 27:67-73.

Rose, M.E., Orlans, E. and Buttress, N. 1974. Immunoglobulin classes in the hen's egg: their segregation in yolk and white. European Journal of Immunology. 5:521-523.

Ryu, K.P. and Lee, K.L. 1997. Changes of Blood Chemical Values in Suckling Calves. Korean Journal of Veterinary Clinical Medicine. 14(2):201-207.

SAS. 1999. SAS user’s guide:sas. Inst., Cary. NC.

Shin, N.R., Kim, J.M. and Yoo, H.S. 2000. Control of swine respiratory disease using egg yolk antibodies I. Analysis of immunogens of *Bordetella bronchiseptica, Pasteurella multocida and Actinobacillus pleuropneumoniae* and production of IgY. Korean Journal of Veterinary Research. 40(3):551-561.

Wiedemann, V., Linckn, E., Kuhlmann, R., Schmidt, P. and Losch, U. 1991. Chicken egg antibodies for prophylaxis and therapy of infectious intestinal diseases. V. *In vivo* studies on protective effects against Escherichia coli diarrhea in pigs. Zentralblatt für Veterinärmedizin. Reihe B. Journal of veterinary. 38:283-291.

Woo, S.R., Kim, J.M., Kwon, C.H., Lee, M.S., Lym, S.K. and Kim, J.Y. 1998. Development of preventive method for enterotoxigenic colibacillosis using egg yolk antibodies 1. Immune responses of hens immunized against combined Escherichia coli pilus antigens and heat labile toxin. Korean Journal of Veterinary Research. 38(4):829-836.

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