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Comparison of Blood Biochemical Values between High and Low Producing Holstein Cows

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Abstract

Comparison of Blood Biochemical Values between High and Low Producing Holstein Cows

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This study investigated blood biochemical values between high and low yielding dairy cows, in order to suggest a means for the improvement of milk production. A total of 30 Holstein cows (3rd to 5th of parity) were used and assigned to two groups according to milk production levels at 15, 30, 60 and 90 days postpartum. Milk production in each of the two groups was less than an average of 27 kg/day (group A) and more than an average of 30 kg/day (group B). Blood samples were collected by jugular venipuncture from each cow six times at 15 days before the anticipated calving date, within 12 hours postpartum (0 days) and at 15, 30, 60 and 90 days after calving.

In hematological values group B was consistently higher than group A in average of RBC, WBC, PCV and total protein. But the level of fibrinogen showed a little fluctuation between the groups at antepartum and 0 days but group A is consistently higher than group B in early lactation. In serum mineral concentrations, group B was consistently higher than group A in both Mg and Ca. Inorganic phosphorus concentrations showed a little fluctuation between the groups at antepartum and at postpartum, but group B is significantly higher than group A at 15 and 30 days after calving ($p<0.05$). In serum biochemical values cholesterol concentrations were consistently higher in group B except at 0 days. BUN and glucose concentrations did not differ between the groups. In the concentration of vitamin A group B is significantly higher than group A at 15 days before the anticipated calving date and at 15 days postpartum ($p<0.01$) but at 30, 60 and 90 days postpartum both groups are similar. Vitamin E concentration did not differ between the groups during the experimental period. Parasitemia-levels were similar in both groups at all times. It was especially notable that both groups showed highest levels of parasitemia at calving time.

Results of this study suggest that raising the levels of Mg, Ca, Pi and vitamin A in serum would be effective in increasing milk production of low producing cows.

Key words: Holstein cows, milk production, blood biochemical values, *Theileria sergenti*

Contents

Ⅰ. Introduction

Milk production is affected by hereditary factors, lactation number, season, length of the dry period, disease and nutrients (Schmidt, 1971). Among these factors nutrient intake is closely related to the prevalence of metabolic disease in lactating and pregnant dairy cows. Nutritional status also plays an important role in mammary development, differentiation and subsequent lactation (Swenson and Reece, 1993). Nutrients are carried from the digestive tract to the tissues by blood as a transport medium. So blood biochemical values are used as an indicator of nutritional status and for the diagnosis of a disease.

During the 1970's greater interest was shown in the metabolic profile testing of dairy cows to identify problem of management and of health (Payne *et al*., 1970, 1973, 1974; Lee *et al*., 1978; Roussel *et al*., 1982a,b). Payne *et al*. (1970) were the first to propose a metabolic profile test suggesting a normal range of blood constituents based on tests carried out on 2,400 cows in 13 herds. In Korea, Lee *et al*. (1993a) reported that using a metabolic profile test to help increase milk production was tried for the first time. Metabolic profiles reflected either dietary inadequacies or disease states. Payne *et al*. (1974) reported that metabolic profiles may be useful when comparisons are made among groups within a given herd. Concentrations of blood constituents in lactating dairy cattle can vary with the stage of lactation (Rowlands *et al*., 1979; Peterson and Waldren, 1981; Forar *et al*., 1982; Kappel *et al*., 1984a,b; Tainturier *et al*., 1984), and with milk yield (Kitchenham *et al*., 1975; Jone *et al*., 1982).

Milk production increases gradually at postpartum and then comes to a peak point of lactation at 4-8 weeks after calving (Swenson and Reece, 1993). During early lactation, there is an increase in the use of nutrients because of milk production and there may also be a higher prevalence of disease during the periparturient period. Therefore nutritional control is very important in the management of dairy cows during the periparturient period.

Plasma vitamin A and serum vitamin E concentrations decrease in periparturient cows (Johnston and Chew, 1984; Smith *et al*., 1997) and because of this, deficiencies of these vitamins are frequently observed during the periparturient period in dairy cows. Also cows, during the periparturient period, are prone to new intramammary infection that contribute significantly to mastitis in dairy herds and reduced milk quality.

Lee (1993b) reported on the changes of blood biochemical values in order to use them as a tool in the diagnosis of disease which occur frequently in Holstein cattle during the periparturient period. Youn and Choi (1985) suggested an analysis of various chemical parameters, which could be used as a method to predict which cows are more susceptible to the parturient syndrome. Kang *et al*. (1996) reported a correlation between serum biochemical values and the incidence of repeat-breeder syndrome which could be used in the early diagnosis of infertility in cows.

As mentioned above, blood biochemistry has been used both as a diagnostic tool and for the screening of nutritional status.

The objective of the study reported here was to present a means for the improvement of milk production through the investigation and the comparison of blood biochemical values between high and low yielding cows.

Ⅱ. Materials and Methods

1. Experimental animals and design

A total of 30 Holstein cows (3rd to 5th of parity) which were anticipated to calve within 3～4 months were selected from a single herd on Cheju island. The animals were healthy and had no clinical mastitis. The cows were fed 3 kg of concentrated feed twice a day, morning and evening and then were allowed to graze *ad libitum.*

Animals were assigned to two groups according to their average of milk production at 15, 30, 60 and 90 days postpartum. Milk production of group A and group B were less than an average of 27 kg/day and more than an average of 30 kg/day respectively.

2. Sampling

Blood samples were collected by jugular venipuncture from each cow six times; at 15 days before the anticipated date of calving, within 12 hours postpartum (0 days) and at 15, 30, 60 and 90 days after calving. Two types of sample tubes were used; one contained no additive and the other contained ethylene-diamine tetracetic acid (EDTA) to examine serum biochemical values and hematological values respectively. Serum was kept frozen at -72℃ for subsequent analyses of Mg, Ca, inorganic phosphorus (Pi), cholesterol, blood urea nitrogen (BUN), glucose, vitamin A and E.

3. Methods of examination

1) Milk production

The milk production of each cow was measured four times at 15, 30, 60 and 90 days postpartum; the mean of the 4 values was used to assign cows to either one of the two groups.

2) Blood examination

Red blood cell (RBC) counts and white blood cell (WBC) counts were determined by hemocytometer. Packed cell volume (PCV) was measured by the microhematocrit method and total protein (TP) with a refractometer (AO spencer, USA). Fibrinogen was calculated as the difference between plasma protein and total protein.

3) Serum examination

Serum was analyzed for magnesium by spectrophotometry using Asan kits (Asan Co., Korea) and calcium by spectrophotometry using Young-dong kit (Young-dong Co., Korea). Pi was measured by automatic analyzer (HITACHI 7170, HITACHI Co., Japan). Cholesterol, BUN and glucose were analyzed by spectrophotometry using Young-dong kit (Young-dong Co., Korea).

Vitamin A and E were measured by high performance liquid chromatography

(HPLC) using 515 pump (Waters Co, USA), 474 Fluorescence detector (Waters Co, USA) and 746 data module (Waters Co, USA).

4) Parasitemia-levels

Parasitemia-levels were examined by counting the *Theileria sergenti* per 1,000 RBC under the microscopic examination of Giemsa-stained blood smear (×1,000).

5) Statistical analysis

The data were analyzed by paired-*t* test. Eight animals were excepted in the statistical analysis owing to the fact that 3 of them produced milk irregularly and 5 of them were within the middle range of milk production levels.

Ⅲ. Results

1. Milk production

The differences of milk yield between the groups are shown in Figure 1. The total average of milk production between 15 and 90 days after calving was 29.2±5.6 kg; 24.4±2.2 kg in group A and 34.0±3.6 kg in group B. In group A average milk production at 15, 30, 60 and 90 days after calving was 25.5 kg±3.0, 27.9±2.7 kg, 24.8±3.0 kg, 20.8±3.8 kg, respectively. And in group B average milk production at 15, 30, 60 and 90 days after calving was 33.5±5.8 kg, 36.5±3.9 kg, 33.7±3.9 kg, 32.3±4.5 kg respectively. At 30 days after calving both A and B groups showed peak milk production and then decreased slowly as time went on. Group A's production decreased more suddenly than Group B's at 90 days post calving.

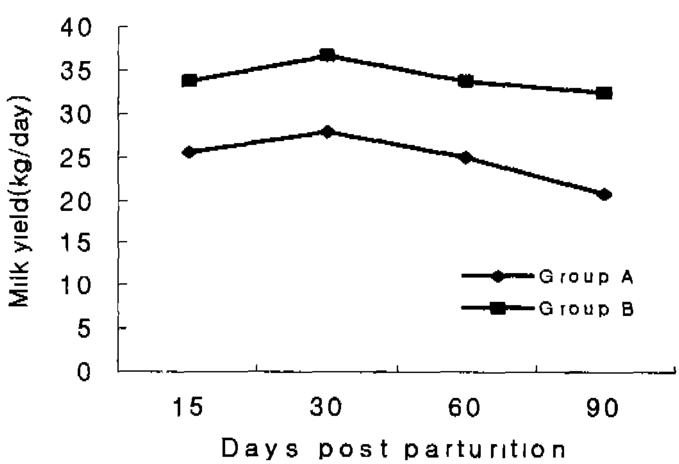

Figure 1. Milk yield of Holstein cows in early lactation periods.

Group A: Low yielding cows, Group B: High yielding cows

2. Hematological Values

The hematological values of animals in each of the groups are shown in Table 1. In hematological values, group B was consistently higher than group A in the averages of RBC, WBC, PCV and total protein during experimental periods. Specifically, group B was significantly higher than group A in RBC at 0 days ($p<0.05$), PCV at 15 days before the anticipated calving date ($p<0.01$), WBC at 15 days before the anticipated calving date ($p<0.05$), at 15 days postpartum ($p<0.01$), 90 days postpartum ($p<0.05$) and total protein at 90 days postpartum ($p<0.05$).

The level of fibrinogen was higher for group B than group A before parturition but group A is consistently higher than group B from the time of calving. Particularly group A was significantly higher than group B in fibrinogen at 15 days after calving ($p<0.01$).

Table 1. Hematological values of Holstein cows according to milk production in early lactation periods.

Day	Group	N	RBC ($10^4/\mu\ell$)	WBC ($/\mu\ell$)	PCV (%)	TP ($g/d\ell$)	Fib ($mg/d\ell$)
BP 15	A	12	413±36.1[1)]	6375±1477^{b*}	28±1.9^{e**}	7.35±0.7	225±125.8
	B	10	458±54.8	10656±3371^{B*}	34±2.0^{E**}	7.41±0.5	287±112.5
PP 0	A	12	404±81.9^{a*}	11922±2836	30±1.3	6.75±0.7	391±162.1
	B	10	493±57.7^{A*}	12731±2633	32±2.1	6.79±0.3	299±110.1
PP 15	A	12	365±34.5	7950±1495^{c**}	26±5.0	7.18±0.8	600±132.3^{G**}
	B	10	394±48.5	12118±2780^{C**}	28±2.3	7.77±0.4	350±117.8^{g**}
PP 30	A	12	441±59.1	9070±1899	28±3.4	8.01±0.2	383±180.0
	B	10	447±59.5	10252±3210	30±2.1	8.3±0.4	350±143.4
PP 60	A	12	508±45.8	11343±2395	30±4.2	8.27±0.3	420±175.4
	B	10	512±61.6	13675±2440	33±1.4	8.42±0.4	390±152.4
PP 90	A	12	523±43.0	11412±3474^{d*}	30±3.6	8.12±0.6^{f*}	525±58.1
	B	10	557±39.0	15337±2559^{D*}	31±2.6	8.62±0.4^{F*}	470±94.8

BP: Before anticipated parturition, PP: Post parturition

A Low yielding cows, B: High yielding cows

N; number of heads, [1)]; means ± SD (Standard deviation) Fib: Fibrinogen

A a, B b, C c, D d, E e, F f, G g; Significantly differential pairs (*p<0.05, **; p<0.01).

3. Serum mineral concentration

The serum mineral concentrations of animals in each of the groups are shown in Table 2. Group B was significantly higher than group A in concentrations of Mg and Ca. Mg showed a significant difference between the groups from 15 days before the anticipated calving time to 15 days postpartum ($p<0.05$) and group B was very significantly higher than group A at 60 days postpartum ($p<0.01$). In Ca, group B was very significantly higher than group A at 15 days before the anticipated calving date, 0 days and at 30 days postpartum ($p<0.01$). Inorganic phosphorus concentrations showed a little fluctuation between the groups at antepartum and postpartum but group B is significantly higher than group A at 15 and 30 days after calving ($p<0.05$).

Table 2. Mineral concentrations of Holstein cows according to milk yield in early lactation periods.

Days	Group	N	Mg (㎎/dℓ)	Ca (㎎/dℓ)	Pi (㎎/dℓ)
BP 15	A	12	1.81±0.35$^{1)a*}$	8.16±0.36^{e**}	6.26±0 61
	B	10	2 12±0.13^{A*}	8.79±0.44^{E**}	6.21±0.71
PP 0	A	12	2.05±0.35^{b*}	7 49±0.72^{f**}	5 73±1.02
	B	10	2 35±0 19^{B*}	8 42±0.42^{F**}	5.06±0.56
PP 15	A	12	1 97±0.23^{c*}	8 50±0 92	4.68±0 52^{h*}
	B	10	2 32±0 23^{C*}	8 68±0 24	5.44±0.64^{H*}
PP 30	A	12	1 81±0 28	8.56±0 38^{g**}	5 11±0 47^{I*}
	B	10	1.83±0 28	9.15±0.36^{G**}	5 61±0.61^{I*}
PP 60	A	12	2 04±0.20^{d**}	8 95±0 24	5 34±0.44
	B	10	2 28±0 10^{D**}	8 97±0 33	5.72±0 52
PP 90	A	12	2 10±0 15	8.55±0.19	5.48±0 77
	B	10	2 23±0 16	8.78±0.59	5 48±0.67

BP: Before anticipated parturition, PP: Post parturition

A: Low yielding cows, B: High yielding cows

N: number of heads, $^{1)}$; Means ± SD (standard deviation)

$^{Aa, Bb, Cc, Dd, Ee, Ff, Gg, Hh, Ii}$; Significantly differential pairs (*; $p<0.05$, **; $p<0.01$).

4. Serum cholesterol, BUN and glucose

Differences of cholesterol, BUN and glucose concentrations among groups are illustrated in Table 3. With the exception of the time of calving (0 days), serum cholesterol concentrations were consistently higher in group B than in group A. At 60 days after calving, group B is significantly higher than group A in cholesterol concentration. There was no significant differences in the blood urea nitrogen and glucose concentrations between the two groups of cows, which were grouped based on their 90-days milk production levels.

Table 3. Concentrations of serum cholesterol, urea nitrogen and glucose of Holstein cows according to milk production in early lactation periods.

Day	Group	N	Cholesterol (mg/dℓ)	BUN (mg/dℓ)	Glucose (mg/dℓ)
BP 15	A	12	66.8±23.0[1)]	14.5±2.01	41.4±10.0
	B	10	76 1±15 2	16.7±3 07	41.4±6.5
PP 0	A	12	77.3±15.4	22 9±4.42	54.2±9.0
	B	10	75.0±10 0	26.1±5 80	56.7±8.9
PP 15	A	12	72.4±22 0	16.7±3.00	49.3±5.4
	B	10	88.9±14.0	14.7±1.08	46.3±6.8
PP 30	A	12	78.1±10 6	17 3±3.05	45 9±3.6
	B	10	88.7±39.0	17 3±3 20	45.4±6.9
PP 60	A	12	111.2±14 7[a]	19 4±2.70	39 1±5.3
	B	10	128.9±13.5[A]	19 5±3.50	39 6±5.4
PP 90	A	12	104 9±17.1	18 6±3.32	42 6±8 7
	B	10	121 5±14.2	17.8±1.94	47.2±4.2

BP: Before anticipated parturition, PP: Post parturition

A: Low yielding cows, B: High yielding cows N: number of heads

[1)] ; mean ± SD (standard deviation) [A,a] ;Significantly differential pair ($p<0.05$)

5. Serum vitamin A and E

Group B is significantly higher than group A in vitamin A (retinol) at 15 days before the anticipated calving date and at 15 days after calving ($p<0.01$). But there is similarity between the groups at 30, 60 and 90 days postpartum (Figure 2).

Vitamin E (α -tocopherol) concentration did not differ between the groups (Figure 3). Vitamin A and E levels showed very low concentration from before anticipated calving to 15 days postpartum (early pasture season; March and April). Then vitamin A and E levels increased in both groups at postparturition.

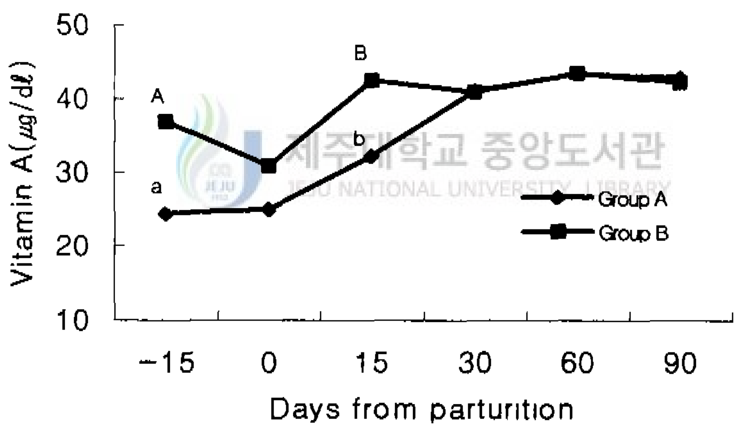

Figure 2. Differences for serum vitamin A between high and low yielding cows in early lactation. At 15 days before the anticipated calving date and at postpartum day 15, group B is significantly higher than group A in vitamin A but at postpartum days 30, 60, 90 both groups are similar. Group A: Low yielding cows, Group B: High yielding cows, A:a, B:b; Significantly differential pairs ($p<0.01$).

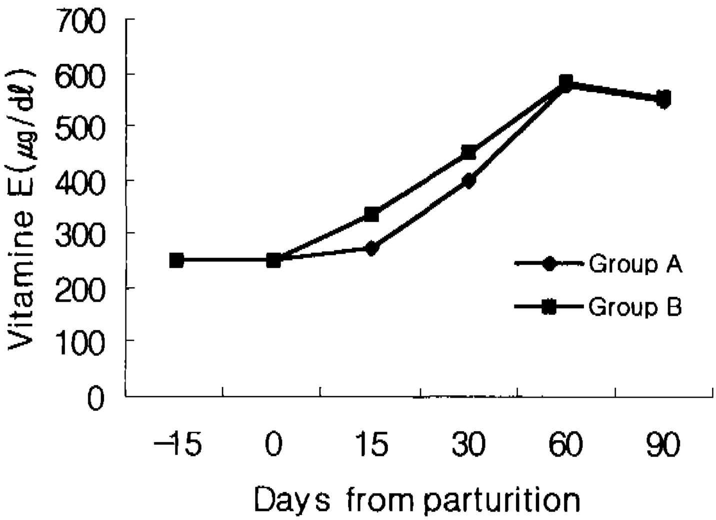

Figure 3. Differences for serum vitamin E between high and low yielding cows in early lactation. Vitamin E (α -tocopherol) concentrations in the groups were similar in early lactation. Group A: Low yielding cows, Group B: High yielding cows

6. Parasitemia-levels

All of the experimental animals were infected with *Theileria sergenti*. While parasitemia-levels were similar in both groups at all times (Figure 4), it was noticed that both groups showed highest levels of parasitemia at calving time; group A (4.45 ±0.69‰) and group B (3.87±1.23‰). Then parasitemia levels decreased slowly in both groups as time went on.

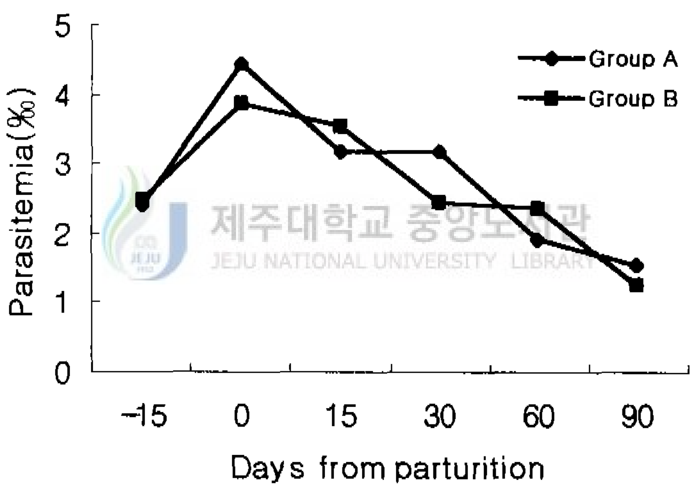

Figure 4. Differences in parasitemia levels of *Theileria sergenti* per 1,000 erythrocyte between high and low yielding cows in early lactation. Parasitemia-levels were similar in both groups at all times. Both groups showed highest levels of parasitemia at calving time. Group A: Low yielding cows, Group B: High yielding cows

Ⅳ. Discussion

Metabolic profile testing is useful to identify dietary causes of disease, or of low production in dairy cows. The test is based on the assessment of blood constituents. In previous research reports most of the variation in blood chemical values was due to differences in herds, stage of lactation and seasonal effect (Payne *et al.*, 1973, 1974; Lee *et al.*, 1978).

Jones *et al.* (1982) reported that high producing herds had higher RBC. Also this report showed that high producing cows were higher than low producing cows in RBC. When compared to the values of RBC from another study (Jones *et al.*, 1982) the values of this research showed slightly lower levels (365 ± 34.5 ~ 557 ± 39.0 $10^4/\mu l$). This result was thought to be due to the fact that all of the experimental animals in this research were infected with *Theileria sergenti*.

PCV is higher in non-lactating cows than in lactating cows (Rowlands *et al.*, 1979) and PCV decreases during early lactation (Kappel *et al.*, 1984a; Wohlt *et al.*, 1984). In this report results also show lower PCV immediately at after calving and then show a slow increase as lactation progresses. Manston *et al.* (1975) reported that lower PCV values results from deficiency of energy and amino acid. It is also known that the cause of lower PCV values can be parasite infection and/or malnutrition. Jones *et al.* (1982) reported that high producing herds had higher PCV values. This study also found that high producing cows were higher than low producing cows in PCV.

Lee (1993b) reported that levels of WBC are increased after calving because of tissue injury and stress from parturition and then they return to the normal range. In this study also WBC tended to increase just after calving and then showed a decrease at 15 and 30 days postpartum. High producing cows had higher WBC than low producing cows. Presumably these results will be related not to an inflammation response but to ACTH (adreno corticotropic hormone) levels from lactation stress.

Total protein level is an index of protein metabolism, the use of nitrogenous nutrients and the transport of hormones (Roussel *et al.*, 1982b). Hullar and Brand (1993) reported that increasing the protein concentration of the diet up to 22% is found to raise milk yield and milk fat concentration. The relationships between the concentration of albumin and milk yield are of greatest statistical significance (Kitchenham *et al.*, 1975) and high producing herds have higher blood albumin (Jones *et al.*, 1982). In this study high producing cows had a higher total protein value. Presumably this result will be due to high yielding cows having higher albumin levels.

Fibrinogen is known to be the most sensitive indicator of inflammation in cows. In this study fibrinogen levels were higher in the high producing group at prepartum but low producing cows were higher from parturition onwards. It was thought that reconstruction of the uterus after calving was late or there may have been a potential inflammation response in the low yielding cows.

The lower Mg concentrations which occur in nonlactating cows are related to the lower intakes of Mg (Rowlands *et al.*, 1979). Jones *et al* (1982). reported that high producing herds were higher than low producing herds in Mg. Also in this study high yielding cows were consistently higher than low yielding cows in concentrations of Mg. And Wolff *et al.* (1978) reported that if a concentration of Mg intake was provided milk production would be increased. It is thought that Mg is one of the nutrients most directly related with milk production during early lactation.

Concentration of calcium in blood decreases because the calcium requirement for milk synthesis exceeds availability at parturition. In this study also the tendency for calcium concentration to decrease after calving was noticed. And concentration of serum calcium tended to decrease as Mg concentration increased. This result is similar to those of a previous reports (McAdam *et al.*, 1982 and Lee *et al.*, 1978). When compared to the values of Ca from other studies (Wholt *et al.*, 1984, Lee et al., 1978) the values of this research showed slightly lower levels (7.49±0.72 ~ 9.15±0.36 mg/dℓ) but none of the experimental animals suffered from milk fever. Shappell *et al.* (1986) reported that feeding lower dietary calcium to cows in the prepartum period was effective in the prevention of severe hypocalcemia at parturition. The results of this study showed that high yielding cows were higher than low yielding cows in the concentration of calcium.

Deficiency of inorganic phosphorus causes depressed or poor growth rates, softening of the bones and reproductive problems (Grace, 1983). And low phosphorus intakes of lactating cows reduced feed intake and milk yield (Eckles *et al.*, 1932). In this research the concentration of inorganic phosphorus showed a little fluctuation between the groups at antepartum and postpartum but high yielding cows were significantly higher than low yielding cows at 15 and 30 days after calving.

Cholesterol levels change over the lactation-pregnancy cycle with low content in early lactation increasing with the number of days milked (Peterson *et al.*, 1981). And Puppione *et al.* (1978) stated that this increase in cholesterol is associated with increased lipoprotein synthesis and changes among the various types of lipoproteins, which are required for lipid transport. This study also showed that cholesterol concentration increased with lactation progressing. Cows conceived with ≤ 2 services have higher serum cholesterol values than did cows requiring more services (Ruegg *et al.*, 1992). Cholesterol concentrations are reported to be directly related to milk production from 25 through 88 days postpartum (Kappel *et al.*, 1984b). Results of this study also showed that blood cholesterol levels were related to milk production.

Serum urea nitrogen concentration in dairy cows has been described as a sensitive indicator of protein intake and solubility. Concentration of serum urea nitrogen are higher in summer and lower in winter because of higher protein intake during the grazing season (Lee *et al.*, 1978). Usually the increase in serum urea concentrations after calving is attributed to a higher dietary supply of nitrogen (Zamet *et al.*, 1979). In this study also BUN increased after calving. But there was no difference in BUN when cows were compared by groups according to milk yield in early lactation.

Concentrations of glucose in blood is related to sufficiency of energy. The decrease in the concentration of glucose at the end of pregnancy may be due to a relatively poor diet and/or a higher energy requirement for fetal anabolism (Tainturier *et al.*, 1984). Erfle *et al.* (1974) and Jenny *et al.* (1974). reported that blood glucose appeared to be a poor indicator of either energy balance or dietary intake of energy, particularly in early lactation. In this study, there was no difference in the concentration of glucose between the two groups during early lactation.

Vitamin A and E are important nutrients, for maintaining health in dairy cattle. While most of the vitamins are synthesized in the body vitamins A and E are not and therefore vitamin A and E need to be supplemented in feed. Jo (1973) reported that serum vitamin A is lower in winter than in summer. And Jonhston and Chew (1984) reported that plasma vitamin A concentrations decreased in periparturient cows. In the concentration of vitamin A, low yielding cows were significantly lower than high yielding cows at 15 days before calving (in early spring). And low yielding cows had very lowered concentration of vitamin A in the early grazing season (before calving). This result indicates that the prevalence of vitamin A deficiency will be higher in low yielding cows which are due to calve before the grazing season. Miller *et al.* (1995) reported that dairy cows had lower serum vitamin E concentrations in winter and early spring. In this study also vitamin E concentration was lower before calving (in early spring), but vitamin E (α -tocopherol) concentration did not differ between the groups. In this study vitamin A and E concentration were increased as time went on (from March to July). These results are due to the fact that the experimental dairy cows were grazing at pasture later on during the research. Due to the low levels of vitamin A and E in cattle before the grazing season there may be a need to supplement feed with vitamin A and E at this time to avoid deficiency.

According to previous studies, on Cheju island the infection rate of *T. sergenti* in imported cattle is 100% in July (Suh *et al.* 1982) and in Holstein cows is 92.5% (Kim, 1998). In this study all of the experimental animals were infected with *Theileria sergenti* although they did not show clinical signs directly. The cause of this high infection rate is the high density of the tick population on Cheju Island. Parasitemia levels were not different between groups but were found to be much higher at calving times for all of groups. This was thought to be due to decreased immunity resulting from parturition stress. Therefore it was thought that treatment for *Theileria sergenti* is advisable before parturition in grazing cows Since theileriasis reduces the levels of RBC and PCV in the blood, it is thought that prevention or treatment of *Theileria sergenti* infection may help increase milk production in dairy cows, especially in areas with a high density of tick population.

The present work has indicated the existence of differences between milk yield and certain blood chemical values during early lactation (from 15 days anticipated before calving time to 90 days postpartum). And milk production declined more suddenly in low yielding cows after the peak production (at 30 days post calving). So it is thought that proper management needs to try to keep up milk yield in low yielding cows during early lactation. Results of this study showed that low producing cows were lower than high producing cows in concentrations of serum Mg, Ca, Pi and vitamin A during early lactation. These results were suggests that if the levels of Mg, Ca, Pi and vitamin A in serum were raised, milk production would be increased in low producing cows during early lactation.

V. Conclusion

Blood biochemical values were investigated in 30 Holstein cows according to milk production in early lactation. The results obtained were as follows.

1. In hematological values, RBC, WBC, PCV and total protein levels were higher in high yielding cows. But fibrinogen levels had a tendency to be higher in low yielding cows.
2. In serum mineral concentrations high yielding cows were higher than low yielding cows in concentrations of Mg and Ca. Inorganic phosphorus concentrations showed a little fluctuation between the groups at antepartum and at parturition but high yielding cows were significantly higher than low yielding cows at 15 and 30 days post partum.
3. Except at calving (0 days), serum cholesterol concentrations were consistently higher in high yielding cows. Both serum urea nitrogen and glucose concentrations were similar in cattle regardless of the level of milk production.
4. High yielding cows were significantly higher than low yielding cows in vitamin A at early pasture season but both groups are similar as time went on from March to July. Vitamin E (α -tocopherol) concentration did not differ between groups.
5. Although parasitemia levels did not differ between groups (by milk production), it was noticed that both groups showed highest levels of parasitemia at calving time.

This research indicates that raising concentration of serum Mg, Ca, Pi and vitamin A may be effective in increasing milk production of low yielding cows.

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초 록

젖소에서 고능력우와 저능력우의 혈액화학치에 관한 연구

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젖소의 혈액화학치를 조사하여 산유량 증가를 위한 방안을 제시하고자 유량에 따른 Holstein 젖소의 혈액화학치를 비교하였다. 공시동물은 건강한 3-5 산차의 Holstein 젖소 30 두로 하였으며 사양관리는 농후사료 1 일 6kg 을 급여하고 방목시켰다. 실험군의 유량을 분만후 15, 30, 60, 90 일에 측정한 후 평균 유생산량을 기준으로 평균 27kg 이하(그룹 A)와 평균 30kg 이상(그룹 B)으로 나누었다. 혈액은 분만 예정 15 일전, 분만 당일, 분만후 15 일, 30 일, 60 일, 90 일에 경정맥을 통하여 채혈하였다.

각 시기별 유량에서 유량이 적은 그룹 A 가 유량이 많은 그룹 B 보다 분만후 60 일에 급속히 감소하였다. 혈액검사 결과에서 적혈구수, 백혈구수, 적혈구용적 및 총단백질은 유량이 많은 그룹 B 가 유량이 적은 그룹 A 보다 높았다. 특히 적혈구는 분만당일에($p<0.05$), 적혈구 용적은 분만 예정 15 일전에($p<0.01$), 백혈구수는 분만 예정 15 일전($p<0.05$), 분만후 15

일($p<0.01$), 분만후 90 일($p<0.05$)에, 총단백질은 분만후 90 일에($p<0.05$) 유의성 있는 차이를 보였다. 섬유소원은 분만전후 다소 변동이 있었으나 분만 당일부터는 유량이 적은 그룹 A 에서 높은 경향이었으며 분만후 15 일에는 매우 유의성 있게 높았다($p<0.01$). 미량원소인 마그네슘과 칼슘은 실험 전기간 동안 그룹 B 가 높았다. 특히 마그네슘은 분만 예정 15 일전($p<0.05$), 분만 당일($p<0.05$), 분만후 15 일($p<0.05$), 분만후 60 일($p<0.01$)에 유의성 있는 차이를 보였다. 칼슘은 분만 예정 15 일전, 분만 당일, 분만후 30 일에 유의성 있는 차이를 보였다($p<0.01$). 무기인은 분만 전후 다소 변동이 있었으나 분만후 15 일과 30 일에는 유량이 높은 그룹 B 가 유량이 낮은 그룹 A 보다 유의성 있게 높았다($p<0.05$). 혈청검사에서 콜레스테롤 농도는 분만 당일에만 두 그룹간에 비슷하였고 그 외의 시기에서는 그룹 B 가 높은 경향이었으며 분만후 90 일에는 유의성 있게 높았다($p<0.05$). BUN 과 글루코오스는 유량에 따른 그룹간 차이가 없이 비슷한 수준이었다. 그리고 비타민 A 는 분만 예정 15 일전과 분만후 15 일에는 그룹 B 가 유의성 있게 높았으며($p<0.01$) 그 이후에는 그룹간에 비슷한 결과를 보였다. 비타민 E 는 유량에 따른 그룹간에 유의성 있는 차이가 없이 비슷한 수준을 보였다. 임상증상을 나타내지는 않았지만 모든 공시동물에서 *Theileria sergenti* 가 관찰되었고 적혈구내 원충의 감염율은 유량에 따른 그룹간 차이가 없이 비슷하였다. 그리고 두 그룹에서 모두 분만 당일에 높은 수치를 보였다. 본 실험 결과는 유량에 따른 그룹간 혈액화학치의 차이가 있음을 시사하였다.

중심어: 산유량, 홀스타인 젖소, 혈액화학치, *Theileria sergenti*

감사의 글

2년 동안의 대학원 생활을 접으며 저에게 힘이 되어 주신 분들에게 감사의 글을 올립니다.

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원유검사에 도움을 주신 축산 진흥원 김은주 선배님, 정경주 수의사님, 제주 낙농업 협동조합 원유검정소 김형진 팀장님, 혈청검사에 도움을 주신 제주의료원 김용근 임상병리실장님과 김은철 선생님께 감사드립니다. 또한 대학원 생활동안 실험실에서 늘 함께 지내온 영수형, 석곤, 지현, 진아 그리고 유리, 규만, 건태, 근배, 일룡에게 고마움을 전하며, 밤샘작업을 같이 하면서 힘이 되어준 용철이형과 창종, 그리고 동물병원 진태정 선생님, 김정훈 수의사와 김정훈 조교선생님, 동규형, 경훈형, 정아에게도 감사의 뜻을 전합니다.

끝으로 변함없이 저에게 관심과 사랑을 쏟아주신 매형, 누나 그리고 형, 형수님들께 저의 작은 결실을 보답으로 올리며 앞날에 건강과 축복이 함께 하기를 빕니다.