



Milking cows before parturition  
by Ervin P Smith

A THESIS Submitted to the Graduate Faculty in partial Fulfillment of the requirements for the degree of Master of Science in Dairy Production  
Montana State University  
© Copyright by Ervin P Smith (1951)

Abstract:

Forty-seven cows and heifers due to freshen were divided into four groups, Group I consisted of Hoisteins that were prepartum milked. Group II consisted of Holsteins used as a check group.

Group III consisted of Jerseys that were prepartum milked. Group IV consisted of Jerseys used as a check group.

Beginning with the seventh day-before the calculated freshening date, blood samples were taken from the juglar vein from all the cows every other day for the determination of blood carotene, vitamin A, calcium and phosphorus.

The prepartum milked groups were milked twice daily beginning the seventh day before the calculated freshening date and all groups were milked twice daily four days postpartum, At each milking a composite colostrum sample was taken from all functional quarters for bacteriological study, the determination of carotene, vitamin A, calcium and phosphorus.

Daily records were kept of the physical condition of the udder, and amount and characteristics of the secretion. Photographs were taken of the udders of both groups during the prepartum and postpartum periods.

The results indicate that Holstein cows when milked prepartum increase in secretion more rapidly than Jersey cows.

The differences in the amount of milk produced by the prepartum milked Holstein group over the control Holstein group was highly Significant at the one per cent level. The differences in the amount of milk produced by the Jersey groups were insignificant' at the five per cent level.

Prepartum milking relieved udder congestion in the Holstein Cows but did not relieve it in the Jersey cows.

The cows in the prepartum milked groups produced milk that was normal or nearly ,so at the time of parturition in carotene, vitamin A, calcium and phosphorus. The carotene, vitamin A, calcium and phosphorus in the blood made a steady decrease as the colostrum flow increased.

The bacterial counts ranged from less than 3000 to over 3,000,000 per ml, of colostrum in the prepartum milked cows and from less than 3000 to 445,000 in the colostrum of the check cows, Ho significant differences in the growth rates of the calves from prepartum and non-prepartum milked dams were noted.

MILKING COWS BEFORE PARTURITION

by

ERVIN P. SMITH

A THESIS

Submitted to the Graduate Faculty

in

partial fulfillment of the requirements

for the degree of

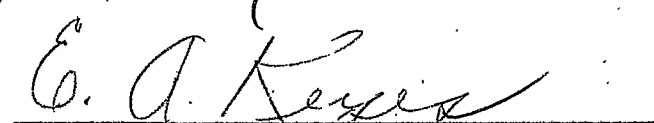
Master of Science in Dairy Production

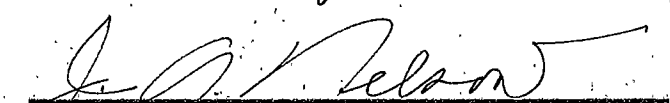
at

Montana State College

Approved :

  
Head, Major Department

  
Chairman, Examining Committee

  
Dean, Graduate Division

Bozeman, Montana  
June, 1951.

N378

Sm 55 m

cap. 2

TABLE OF CONTENTS

ABSTRACT.....	4
INTRODUCTION.....	5
REVIEW OF LITERATURE.....	7
PREPARTUM MILKING.....	7
Advantages and Disadvantages.....	7
Effect on Production.....	9
Mammary, Edema or Udder Congestion.....	10
Milk Fever or Parturient Paresis.....	13
Blood Analysis.....	15
Composition of Colostrum, Prepartum and Postpartum.....	21
Bacteriological Observations.....	27
COLOSTRUM AND EARLY NUTRITION OF THE CALF.....	29
General.....	29
The Anti-Body Effect of Colostrum.....	31
Vitamin A and Carotene.....	34
Calcium and Phosphorus.....	40
EXPERIMENTAL PROCEDURE.....	41
Feeding and Management of the Cows.....	41
Determination of Blood Plasma Vitamin A and Carotene.....	43
Determination of Blood Plasma Calcium.....	45
Determination of Blood Plasma Phosphorus.....	47
Determination of the Vitamin A and Carotene Content in Milk.....	48
Determination of Milk Calcium.....	51

Gift of Graduate Committee

Determination of Milk Phosphorus.....	52
DISCUSSION OF INDIVIDUAL COWS AND GROUPS.....	53
DISCUSSION OF RESULTS.....	102
SUMMARY AND CONCLUSIONS.....	116
ACKNOWLEDGMENTS.....	120
LITERATURE CITED.....	121
APPENDIX.....	A.1.

ABSTRACT

Forty-seven cows and heifers due to freshen were divided into four groups. Group I consisted of Holsteins that were prepartum milked. Group II consisted of Holsteins used as a check group. Group III consisted of Jerseys that were prepartum milked. Group IV consisted of Jerseys used as a check group.

Beginning with the seventh day before the calculated freshening date, blood samples were taken from the juglar vein from all the cows every other day for the determination of blood carotene, vitamin A, calcium and phosphorus.

The prepartum milked groups were milked twice daily beginning the seventh day before the calculated freshening date and all groups were milked twice daily four days postpartum. At each milking a composite colostrum sample was taken from all functional quarters for bacteriological study, the determination of carotene, vitamin A, calcium and phosphorus.

Daily records were kept of the physical condition of the udder, and amount and characteristics of the secretion. Photographs were taken of the udders of both groups during the prepartum and postpartum periods.

The results indicate that Holstein cows when milked prepartum increase in secretion more rapidly than Jersey cows.

The differences in the amount of milk produced by the prepartum milked Holstein group over the control Holstein group was highly significant at the one per cent level. The differences in the amount of milk produced by the Jersey groups were insignificant at the five per cent level.

Prepartum milking relieved udder congestion in the Holstein cows but did not relieve it in the Jersey cows.

The cows in the prepartum milked groups produced milk that was normal or nearly so at the time of parturition in carotene, vitamin A, calcium and phosphorus. The carotene, vitamin A, calcium and phosphorus in the blood made a steady decrease as the colostrum flow increased.

The bacterial counts ranged from less than 3000 to over 3,000,000 per ml. of colostrum in the prepartum milked cows and from less than 3000 to 445,000 in the colostrum of the check cows.

No significant differences in the growth rates of the calves from prepartum and non-prepartum milked dams were noted.

## INTRODUCTION

Progressive dairymen have always been interested in increasing the productivity of their dairy cows. Selection, better feeding and nutrition practices, management, and artificial insemination, have contributed to bring about higher production.

These factors as well as others have been largely responsible for yearly herd averages ranging from 400 to 500 pounds or more of milk fat.

As the production of dairy cows is increased, the problems of properly caring for them are also increased. Higher production puts much more stress and strain upon the producing animal, especially upon the udder. A sound udder is very essential for maximum as well as economical milk production.

In many cases the udder of the dairy cow becomes congested, inflamed and sore as freshening time approaches. This congestion and soreness in the udder can cause the cow to be very uncomfortable and ill at ease, which is conducive to udder injuries which may result in mastitis.

A few dairymen have practiced milking cows before parturition, sometimes referred to as prepartum milking or premilking, in an attempt to lessen udder congestion occurring previous to and immediately following freshening.

Some dairymen considered that by premilking, the cow could be brought to her normal milk flow more rapidly because of an improved

condition of the udder.

If prepartum milking will relieve congestion in the udder and condition it for normal milk flow, it should result in bringing the cow to full feed sooner than would otherwise be possible. This could be conducive to increased milk production for the lactation period. Furthermore, if the incidence of milk fever can be lessened and the well being of the calf not jeopardized by pre-milking, it would be a beneficial practice in the care of high producing dairy cows.

In view of these objectives, this experiment was undertaken.

REVIEW OF LITERATURE

PREPARTUM MILKING

Advantages and Disadvantages

The first workers to milk cows before parturition, commonly called "prepartum milking" or "premilking", was Professor Boutflour of the Royal Agricultural College in England, according to Davis and Trimberger (22). He did considerable work on premilking of dairy cows and reported excellent results. It was upon his recommendation that the Mount Hope Farm of Williamstown, Massachusetts, began premilking their cows, which is now a regular practice at that farm. Prentice (83) reported that the premilking done at Mount Hope Farm resulted in the elimination of milk fever and caked udders. He also reported that calves from premilked cows did not do very well due, presumably, to the absence of colostrum.

The "Holstein-Friesian World" (85) reported that premilking seems to prevent congestion or badly caked or swollen udders and may even increase production because cows and heifers can be brought up to full feed more rapidly.

The Nebraska Agricultural Experiment Station (22) reported that the swelling, inflammation and physical strain to which the udder is subjected can be greatly reduced by milking before parturition. Some loss of calves resulted, due, presumably, to a smaller amount of colostrum for the new born calf.

Bailey (4), listed the following advantages of premilking dairy cows :

1. Reduction in severity or complete elimination of caked udders.
2. Heifers can be trained to milk with greater ease due to the absence of inflammation and soreness of the udder.
3. Eliminates much of the danger of milk fever.
4. The cow can better prepare herself for milk production when not upset by calving.
5. Reduces the tendency towards pendulous broken-down udders.

He reported the following disadvantage :

The calves would not get colostrum needed for the protective substances called anti-bodies.

The "Holstein-Friesian World" (84) published an article entitled "What Has Been Your Experience with Prepartum Milking and Use of Colostrum?" This question was answered by several outstanding herdsmen. Some of the answers were as follows :

An outstanding dairy farmer believed in prepartum milking and practiced it all the time. The herdsman believed that it relieved the strain on udder attachments, prevented excessive udder congestion, especially in animals in high flesh. He also felt that heifers were more easily trained.

Another dairy farmer stated that it kept down inflammation, the udder attachments remained strong for a longer period of time and the cow could be put on full feed sooner after freshening. There were several other similar answers.

Effect on Production

Keyes and co-workers (62) did considerable premilking work at the Pennsylvania Agricultural Experiment Station. They found that the per cent of milk fat remained between four and five per cent from the eleventh day before calving to the day of parturition. As calving time approached, the per cent fat increased to about five per cent and remained there for at least four days after parturition. The non-premilked cows averaged about 4.5 per cent on the day of freshening and stayed just under five per cent for at least four days after freshening.

The average total pounds of milk for the prepartum milked cows started at about a pound a day and increased at a rate of one to two pounds a day until the third day before calving, when it increased at the rate of five to six pounds per day. A total of 25 pounds was reached the day of calving. This increased to 42 pounds the fourth day after calving. The non-prepartum milked cows started at twenty one pounds the day of freshening and increased to 37 pounds the fourth day after freshening.

Bawdy and Knodt (21) determined the effect on milk production by prepartum milking one half of the udder and non-prepartum milking the other half. A comparison for the first 30 days postpartum of 15 first lactation heifers having apparently balanced udders, resulted in an average production of 529.4 pounds of colostrum for the 15 pre-milked halves, and 490.2 pounds for the 15 non-premilked halves. There was a total of nine mature cows and heifers upon which records

were kept for a period of seven months of their lactation that had balanced udders. The prepartum milked halves averaged 5061 pounds of milk, while the non-prepartum milked halves averaged 4780 pounds or an average difference of 280 pounds of milk in favor of the premilked halves for the first seven months of lactation.

Ackerman and co-workers (1) found considerable variation in the amount of colostrum produced. Six cows produced less than two pounds the day preceding parturition, four cows produced from two to ten pounds, five cows produced from eleven to twenty pounds, and nine produced over 20 pounds.

#### Mammary Edema, or Udder Congestion

Bailey (6) stated that the cause of udder congestion is an accumulation of milk in the udder which creates pressure, that interferes with the circulation of the blood and lymph. His recommended treatment for udder congestion is frequent milking, plenty of exercise, withholding of grain, massaging of the udder, and pre-milking.

Olson (76) stated that usually there is considerable congestion in the udder prior to freshening. This is particularly true if the cow has been well fed and is in good condition. Milking out the cow may relieve this congestion, but it is better for the calf not to be thus deprived of the colostrum milk. In extreme cases, when the condition persists after the calf is born, the calf may be left with the cow, as its massaging action during nursing seems to relieve

congestion.

Peterson (81), stated that high producing cows usually suffer from a congestion of the udder immediately following calving. When this congestion occurs, it lasts for varying lengths of time. In some cases the congestion is due in part to an infection. In the majority of cases, however, it is a natural sequence to the rapid development of the gland and is caused by an accumulation of fluid (or lymph) in the gland tissues. The degree of congestion is influenced by a number of factors. Exposure to drafts and chills often intensifies the congestion and may lead to infection. The higher producing cows are more subject to congestion of the udder than are lower producers. Cows in high condition also suffer from greater congestion than do those in poorer condition. The claim by some that certain feeds are specifically conducive to udder congestion, is not warranted by fact. In extreme cases of congestion milking becomes very difficult because of the shortened teats and the slowness with which the milk is let down. When this is the case it may be advisable to leave the calf with the cow until the congestion has somewhat reduced. Some believe the massaging of the udder by the calf while nursing is helpful in reducing the congestion. Additional vigorous massaging by the hands will help to start the flow of the lymph out of the tissue and reduce the congestion.

In a report by Peterson (81) on the result of several recent studies, prepartum milking has been demonstrated to be the most

satisfactory solution of the congested udder problem. He stated that milking should be started as soon as signs of congestion develop. With the beginning of milking, not only is further progress of congestion stopped, but the swelling that is present will gradually disappear. Work thus far indicates that prepartum milking will not depress milk flow following parturition. In prepartum milking there will be no colostrum following freshening, and provisions for this substance for the newborn calf must be made in other ways. The first two or three milkings (prepartum) will result in normal colostrum which may be preserved for the calf by freezing. Petersen (81) stated that prepartum milking is also a factor in preventing a breaking away of the udder. The excessive swellings that sometimes occur puts more weight and stress on the suspensory ligaments than they are able to withstand, and a breakdown results. Mastitis may be lessened to some extent by prepartum milking because the excessively large swollen udder is more subject to injury and thus predisposed to infection.

Prepartum milking has been proposed by several other authors (20, 36, 81, 111) for the reducing or decreasing mammary and umbilical edema.

Ackerman and co-workers (1) did some premilking with special attention to the congestion of the udder and lymphatic edema both before and after parturition. They found considerable variation within groups. The results indicated, however, that prepartum milking neither reduced the amount of congestion or edema nor the length of

time required for the udder to become normal.

Eaton and co-workers (31) reported that prepartum milking did not affect significantly the mammary and umbilical edema present at parturition.

Bailey (5) stated that "recent experiments indicate that milking for a week or ten days before freshening is valueless as a means of preventing this trouble. If started as much as three weeks before freshening, we suspect that the practice might be of some help in preventing udder congestion".

#### Milk Fever or Parturient Paresis

Olson (76) stated that the blood of cows which develop milk fever is low in calcium. Only cows of heavy milk production are subject to the disease. Milk fever rarely, if ever, attacks first calf heifers. If a cow is coming down with milk fever the condition will as a rule be indicated during the first three to five days after freshening. However, cows have been known to have milk fever previous to freshening and later in the lactation period.

The first symptom noted in the cow is restlessness. Soon she loses control of the rear quarters and falls. She lies very quietly and apparently does not suffer any pain. Frequently her head will be directed toward her rear flank. She lies in a coma until she is relieved or dies.

Heavy producing cows have a great impulse for milk secretion. In milk fever cases, as the blood goes through the udder, calcium is removed faster than it can be replaced. When the amount of calcium

in the blood falls below a certain level, milk fever results. If milk is left in the udder, a back pressure is built up, retarding milk secretion and thus keeping the calcium in the blood at a safe level. It is well, therefore, not to milk out the udder of cows subject to milk fever, at least for the first two or three days.

Petersen (81) gave a similar explanation. He stated that milk fever is a disease usually limited to high producing cows. While it may occur at any time during the lactation period it rarely occurs except following calving. The first symptom of this disease is staggering, with particular lack of control of the hind legs. The disease advances with progressive paralysis and ends in prostration and complete coma, and unless relief is administered, it terminates in death. When complete coma has appeared, the cow lies with her head turned back against her chest. The eyes have become glassy and she will not respond to pin pricks. The temperature becomes lower rather than higher, as is indicated by the name.

According to other investigators (11, 22) milk fever is caused by a lowering of the calcium salts of the blood. Reducing the calcium salts of the blood by intravenous injection of sodium citrate brings about symptoms analagous to milk fever. Intravenous injection of calcium chloride brings about rapid recovery. The lowering of the blood calcium to produce milk fever can be explained by the fact that whole milk, which contains about 20 times as much calcium as blood, is rapidly being produced. The calcium is being withdrawn from the blood. The mechanism for releasing calcium stored in the body to

replenish the blood is not functioning. This could explain why leaving most of the milk in the udder when milking for the first days following calving helps prevent milk fever.

Smith and co-workers (100) did considerable work on milk fever or parturient paresis. They reported that the complete milking immediately following parturition did not increase the incidence of parturient paresis or milk fever.

Many other workers have proposed that prepartum milking would reduce the incidence of parturient paresis or milk fever (12, 32, 32, 74, 11, 115, 116). Work done at the Missouri Agricultural Experiment Station (88) indicates that prepartum milking has a tendency to prevent milk fever in cows by bringing them into lactation gradually but that this practice may be unsatisfactory for the well being of the calf.

Smith and Blosser (99) also did considerable work on parturient paresis and reported that prepartum milking did not significantly reduce the incidence of parturient paresis. It would seem from the results of this study that factors in addition to the initiation of milk secretion are involved in causing parturient paresis or milk fever.

#### Blood Analysis

Keyes (62) determined the blood plasma carotene every two days on prepartum milked cows, beginning with the sixth day before freshening and continuing to the fourth day after freshening. The blood contained 0.31 milligrams per cent the sixth day prepartum.

One day before freshening there was a sudden drop to 0.1 milligram per cent. After freshening there was a rise to 0.25 and then it again dropped to a low of 0.03 milligrams per cent.

Johnson and co-workers (58) milked one group of cows 10 days before the calculated freshening date, and another group after freshening. Total hemoglobin, plasma carotene and vitamin A, serum calcium and phosphorus, were determined on venous blood samples drawn at weekly intervals beginning four weeks before freshening. They concluded from their experiment that no apparent differences in blood constituents were noted between groups. Total hemoglobin increased slightly at parturition and decreased thereafter to a slightly lower level than that obtained during the four week prepartum period. Both plasma carotene and vitamin A showed a marked drop at the time of parturition and increased thereafter. These constituents did not attain the same level as that found prepartum. Serum calcium and serum phosphorus dropped appreciably at parturition and returned to the prepartum level within a week after calving.

Eaton and co-workers (31) reported that prepartum milking had no significant effect on the blood constituents at parturition.

Wise and co-workers (120) found that the feeding of supplemental vitamin A increased the level of this vitamin in the blood, but reduced the carotenoid values. Supplemental feeding of vitamin A during the latter part of the gestation period did not prevent the characteristic decline at parturition. It did maintain a

higher level in this period than observed in cows not getting supplemental vitamin A. The differences in vitamin A intake of the two groups were reflected in the concentration of vitamin A in the liver. There was no evidence of a correlation between vitamin A levels in the blood and vitamin A in the liver.

Moore (71) reported that the different breeds kept under similar conditions of feeding ranged in increasing order of plasma carotene values as follows :

Brown Swiss  
Holstein  
Ayrshire  
Jersey  
Guernsey

Within the breed there was little difference in the level of plasma carotene values among cows producing milk under winter conditions. Heifers within a breed had definitely lower plasma carotene values than producing cows. Cows producing the larger amount of milk within a breed in general showed a greater increase in the level of plasma carotene when they were turned out on pasture.

Sutton and co-workers (107) reported that both vitamin A and carotene were found to decrease markedly in the blood plasma at the time of parturition and beginning lactation. Under the conditions of their experiment the maximum decrease in blood plasma carotene was reached one week following parturition and amounted to 46 per cent of the three week prepartum level. The maximum decrease in blood plasma vitamin A for the entire group was reached three days following parturition.

Moore (72) reported that the feeding of carrots or green feed to cows caused an increase in both carotene and vitamin A activity of the milk fat. The feeding of cod-liver oil resulted in increased vitamin A activity only. The degree of yellow pigmentation remained unchanged. He stated that "this points to an incomplete conversion of carotene in the cow, or even to an interchangeability of the functions of the pigment and vitamin in this animal." It was found that only a small amount of carotene was present in the liver of oxen. On examining blood-fat and body-fat it was found that only small amounts of chromogenic material were present, which suggested that the main reserves of vitamin A are concentrated in the liver of the cow.

According to several research workers (8, 55, 56, 77, 92, 112, 113) the level of inorganic phosphorus in the blood of dairy cattle is especially sensitive to low levels of phosphorus intake, to deficiencies of vitamin D in the ration or to exposure of animals to sunshine or ultra violet light. One author (113) stated that since low phosphorus rations cause an immediate lowering of the inorganic phosphorus in the blood, the concentration of inorganic phosphorus in the blood is an important index to the severity of a phosphorus deficiency if one exists. Two workers (94, 113) assumed that if a ration just capable of supporting a normal concentration of inorganic phosphorus in the blood is adequate in phosphorus for all prevailing functions, providing the ration is well balanced in all other respects, then the blood inorganic phosphorus level

may be readily applied in the determination of the minimum phosphorus requirement of cattle. In order to determine the minimum phosphorus requirement by this means it is necessary to know the normal level of blood phosphorus of animals at various ages, and the effect of such factors as pregnancy, lactation and various environmental conditions.

Van Landingham and co-workers (117) found that the inorganic phosphorus in the blood of growing dairy heifers increased with age up to about the seventh or eighth month after which there was a gradual decline as the animals grew older. There was also a decrease in the blood inorganic phosphorus of lactating cows with an increase in the number of lactations up to about the third or fourth lactation. During the period of first gestation a lower concentration of inorganic phosphorus is present in the blood of heifers than in that of unbred heifers of approximately the same age. There was a strong tendency for dairy cows after the first lactation to show a lower concentration of inorganic phosphorus in the blood during the winter and early spring than during the summer and early fall.

Normal values for the inorganic phosphorus content of blood serum or plasma have been reported by several investigators. Henderson and Van Landingham (51) reported that the inorganic phosphorus content varied considerably from day to day, and that alternate day sampling proved to be the most satisfactory. They found that for normally fed animals the inorganic phosphorus level in the blood should

be above 4.50 milligrams per cent. Robinson and Huffman (91) found that the inorganic phosphorus level had a range of 3.00 to 8.99 milligrams per cent with an average of 5.87. The value varied a maximum of 1.87 milligrams per cent in twenty four hours. Anderson and co-workers (3) stated that the normal level of phosphorus is between 5.30 and 5.75 milligrams per cent. Johnson (59) reported that the average inorganic phosphorus content of the blood of 64 milking cows was 4.33 milligrams per cent with a standard deviation of 0.59. Haag and Jones (45) found that the normal decline with age may continue well into the third or possibly the fourth year. The average normal value for mature cattle is approximately 5.2 milligrams per cent. Van Landingham and Henderson (112) discovered a decided drop in the inorganic phosphorus of the blood at or immediately following parturition. This drop was more pronounced in the case of animals on a low phosphorus ration. Milk production combined with low phosphorus intake caused a lowering of the inorganic phosphorus in the blood. The blood phosphorus level ranged from 5.36 milligrams per cent for the dairy cows fed the ration containing the normal amount of phosphorus to a low of 2.91 in those cattle fed a phosphorus deficient ration. These workers considered everything with a value of 3.84 milligrams per cent or below as deficient.

Johnson and co-workers (58) found no apparent differences in the blood constituents of prepartum and non-prepartum milked cows. They reported that the phosphorus and calcium dropped appreciably at

parturition and returned to a prepartum level within a week after parturition.

Palmer, Cunningham and Eckles (78) stated that the calcium content of the blood of dairy cattle is subjected to significant fluctuations. The reason was undetermined. Haag and Jones (45) reported on 160 normal blood plasma calcium values. The values ranged from 8.05 to 11.48 milligrams per cent with an average value of 9.99. Anderson and co-workers (3) found that the average value of calcium for cattle was 12.63 milligrams per cent with a range of from 9.96 to 16.18. Niedermier and Smith (75) found that there was an appreciable drop in blood calcium on the day of parturition. Higher than normal levels of blood calcium occurred on the third or fourth day postpartum, which seemed to be the times of greatest intra-mammary pressure.

#### Composition of Colostrum, Prepartum and Postpartum

Petersen (81) stated that colostrum differs from normal milk in many ways. It has ten or more times as much vitamin A, depending upon the carotene and vitamin A content of the pregnant cow's ration. It contains about twice as much dry matter. The protein content is about 13 per cent compared to about 3.5 per cent for normal milk. Most of the protein is in the form of globulin which contains the anti-bodies. Colostrum contains about five times as much tocopherol as normal milk, about four times as much riboflavin, twice as much thiamine, seven times as much choline and about twice as much calcium, phosphorus, sodium and chlorine and three times as much magnesium.

It is also higher in potassium, iron, copper and manganese than normal milk.

Ragsdale and Brody (86) reviewed the chemistry of colostrum and noted that the salt and fat content was low. Casein was about the same as in normal milk, but the level of globulin was twice as high. Compared to milk which contains 0.03 per cent of globulin, colostrum contains 6.0 to 12.0 per cent.

Sato and co-workers (94) called attention to the great variability in the chemical composition of colostrum. They gave the following ranges for the constituents of colostrum :

Solids.....	12.0 - 27.0 per cent
Casein.....	3.0 - 6.0 per cent
Albumin.....	0.3 - 12.0 per cent
Fat.....	1.0 - 13.0 per cent
Ash.....	0.6 - 1.0 per cent

The growth-promoting, anti-infective vitamin A is closely related to the yellow pigment (carotene) content. A study of the colostrum and milk from each of 14 cows made by Dann (20) revealed that there may be from 10 to 100 times as much vitamin A in colostrum as in normal milk, regardless of the season. The importance of colostrum for the calf is demonstrated by the fact that on the first day of life the calf receives supplies of vitamin A greater than the normal milk could give in 20 to 50 days.

Vitamin A and carotenoids in colostrum from dairy cows have been the subject of numerous investigations. It has been observed that levels of these constituents generally are high in the initial colostrum and colostric fat, but decrease rapidly as the mammary secretions change

to normal milk (26, 35, 48, 52, 65, 79, 80, 89, 91, 103, 104, 105, 106, 107, 112, 115, 116, 121). Similar changes were noted in colostrum from sheep (95) and from women (66).

Sutton and Krauss (109) reported the differences in the ability of the breeds to transfer feed carotene into milk carotene, as well as the effect of pasture feeding on carotene output. The carotene content of the normal milk fat of the breeds increased in the following order :

Ayrshire  
Holstein  
Jersey  
Guernsey

The lack of correlation between the carotene content of milk fat and the total vitamin A activity of the fat is thought to be due to inherent breed characteristics. These characteristics apparently regulate the degree of transformation of carotene, the precursor of vitamin A, to vitamin A in the process of milk fat formation.

In one study (105) supplementation of the ration of preparturient cows with vitamin A and carotene by feeding carrots, did not appear to increase levels of these constituents in the colostrum. Others found that pasture increased the carotene (52) and the total vitamin A potency (65, 89).

Hansen and co-workers (48) found that there was a marked increase in the blood plasma vitamin A concentration of the new born calf following the ingestion of colostrum. This tended to reflect the concentrations of vitamin A present in the colostrum of their dams.

When cows were isolated from their calves the vitamin A potency of their colostrum for the first and second milkings was about the same. However, cows which were allowed to remain with their calves and in addition were milked out twice daily, showed a decided drop in vitamin A potency between the first and second milkings. The intravenous injection of 10 I.U. of oxytocin at the time of milking in cows isolated from their calves also produced a similar drop in vitamin A potency between the first and second milkings. The chief drop in concentrations of vitamin A in the change from colostrum to normal milk occurred during the first three milkings following parturition. Thereafter, there was a gradual drop in vitamin A concentration over a period of several days to the concentration found in milk produced in mid lactation.

Garrett and Overman (40) stated that at parturition the specific gravity of total solids and total ash, protein and fat are high. These initial values are followed by a fairly steady decline during the colostrum period.

Prepartum milking for 10 days prior to parturition has been found by several investigators (34, 73, 111, 115, 116) to result in the production of colostrum which resembles milk in approximate composition. The proportion of various proteins, albumin, casein and globulin are altered markedly. The carotene content of colostrum from cows milked prepartum has been found by Keyes (62) to rise on the day of parturition.

Parrich and associates (80) reported that cows and heifers milked

eight to twelve days prepartum produced secretions in the early stages that resembled colostrum and rapidly assumed the characteristics of normal milk in subsequent milkings. Only small, if any, further changes were noted at the time of calving. No marked differences were obtained in the nature of the secretions when oxytocin was used.

Eaton and co-workers (32) reported that prepartum milking resulted in a significant decrease in the carotene, vitamin A, protein and ash contents, and in the specific gravity of colostrum for the first six milkings postpartum. Both carotene and vitamin A decreased with successive milkings in the colostrum of cows milked for more than ten days prepartum. Parturition affected this decrease in carotene and vitamin A by temporarily causing a slower decrease in these constituents.

Eaton and co-workers (27) reported that the first milking postpartum from prepartum milked cows was similar in composition to normal milk, especially in those cows milked for at least 10 days before calving. The colostrum produced at the first milking after calving from cows not premilked, contained approximately five times as much carotene and vitamin A, three to four times as much protein, one half as much lactose, slightly more fat and one and one-fourth times as much ash as the colostrum obtained from the prepartum milked cows. These values decreased with successive milkings. Prepartum milking materially altered the composition of the first milk secreted at parturition. Analysis of this milk indicated that it is much lower

in nutritive value.

Eaton and co-workers (28, 29) reported work on the approximate composition of two pound increments of the first milking postpartum, and found that the carotene, vitamin A and fat increased with successive increments, while lactose and ash decreased and the protein remained essentially the same. The same trend was observed when cows were milked prepartum and postpartum.

Keyes (32) found a great deal of variation in the per cent total solids until about the seventh day before freshening. Then the total solids became more uniform in percentage and gradually approached normal at time of freshening. Three days after freshening the prepartum milked cows and non-premilked cows averaged the same in per cent of total solids. He also found that as milk carotene increased, the carotene in the blood decreased. Starting at 0.03 milligram per cent, the colostrum carotene increased to 0.24 the day before freshening. The day of freshening the colostrum carotene increased to 0.4 milligram per cent, then decreased to 0.1 per cent on the fourth day postpartum.

Stewart and McCallum (104) determined the vitamin A in colostrum colorimetrically, primarily from Ayrshire cows. They found that it decreased rapidly from the first day after calving. In three to four days the colostrum values were normal. The colostrum in vitamin A content ranged from 85 to 92 International Units. They obtained no positive evidence that the vitamin A level was related to the age of the cow, date of calving, breed or even the feed, although they did

not explore the last possibility very extensively. They did find that the lower vitamin A values usually occurred in cows that had had a short dry period. They suggested that the vitamin A storage in the liver may be an important factor.

Garrett and Overman (40) measured the rate of decline in the mineral composition of colostrum. They found most of the mineral elements were high but decreased during the early hours of lactation.

Van Landingham and co-workers (114) observed wide variations in the total nitrogen, ascorbic acid and riboflavin content of colostrum produced by cows milked before parturition. The composition of the colostrum at parturition was related to the level of production and the total amount produced before parturition. The total nitrogen in colostrum from prepartum milked cows the day of parturition, averaged 727 milligrams per 100 ml. Milk produced by 11 cows not milked prepartum averaged on the third day following parturition, 737. Ascorbic acid decreased from an average of 18.5 milligrams per liter three days before parturition to 4.7 on the day of parturition and to 4.3 on the third day following parturition. Riboflavin decreased from an average of 6.53 milligrams per liter three days before parturition to 2.70 on the day of parturition and to 1.90 the third day following parturition.

#### Bacteriological Observations

Copeland and Olson (16) found the average of 657,000 leucocytes per ml. in colostrum. The bacterial counts on colostrum obtained from

individual quarters of the udder varied from 10 to 650,000 per ml. The bacterial counts on the colostrum from the rear quarters were found to be slightly higher than those from the front quarters. In additional studies of colostrum from cows of various age groups, these workers observed that cows past maturity had higher leucocyte and bacterial counts than found in colostrum from younger cows. An average of 331 bacteria and 420,300 leucocytes per ml. were found in 12 cows under four years of age, whereas 11 cows over seven years of age had an average of 8,282 bacteria and 1,559,000 leucocytes. The highest bacterial content of colostrum was observed one week after parturition.

Ragsdale, et al. (88), found that when pregnant heifers were milked at regular intervals prior to calving, there was a high death rate among the calves. Bacteria isolated from the viscera of these dead calves indicated a Bacillus Coli (Escherichia coli) infection. These research workers did not draw any conclusions because the information was regarded as being too limited.

Keyes, et al. (62), reported finding of streptococci of all three hemolytic types in the bovine udder secretion whether the animal was premilked or not. These organisms, constituting the majority of organisms found, were present in highest concentrations in the first milkings. Leucocyte counts showed a good correlation with the bacteria counts. The streptococci were generally found to decrease in numbers until four days after freshening when they could not be detected in most animals. These results were based upon uncentrifuged

slide preparations. Microscopic observations were made of the sediment from centrifuged colostrum which displayed the presence of streptococci at all times indicating that they constitute part of the normal flora of the udder. Injury to the udder or illness of the animal brought about a higher concentration of streptococci in the udder secretion.

Anderson and MacLeod (2) reported that the average leucocyte count of milk samples of postpartum milkings of healthy cows is not affected by prepartum milking.

#### COLOSTRUM AND EARLY NUTRITION OF THE CALF

##### General

The importance of colostrum in the nutrition of young animals has been known since very early times. Sutton and Kaeser (108) found that extending the colostrum feeding period is of great benefit to the calf. Considering that several workers (4, 22, 83, 84) have stated that prepartum milking deprives the calf of colostrum and that colostrum is necessary for the well being of the calf, it is well to consider the role of colostrum in the nutrition of young calves.

About 1920 a series of experiments was started that revealed the importance of colostrum in the nutrition of the calf. Howe, (54) while studying the fat metabolism of calves, found that they passed meconium readily without colostrum but later there was some delay in defecation. He also found the feces of young calves to be rich in coagulate protein.

Savage and McCay (96) reported in a review of the nutrition of the calf that Smith and Little found much albumin in the urine of the calf during the first three days of life. Both albumin and globulin appeared in the urine of the calf consumed colostrum. The feces were about one-third dry matter. Ten to 15 per cent of this dry matter was fat and soaps. The calves seemed able to digest but not able to absorb the fats.

Howe (54) found that the blood of the calf contained neither euglobulin nor pseudoglobulin I at birth. If calves were fed colostrum instead of milk these fractions appeared in the blood stream in the course of a couple of days.

In 1922 new emphasis of the importance of colostrum was given by a number of investigations. Savage and McCay (96) stated that Little and Orcutt found that colostrum provided the agglutinins for B abortus found in the blood of calves. Neither the foetal blood nor that of the unfed calves contained these agglutinins.

According to Savage and McCay (96) Smith and Little called attention to the neglect of most text books in stressing the importance of the colostrum in the early nutrition of the calf.

These same investigators also reported that Orcutt and Howe found milk would not produce the globulin fractions in blood even 21 hours after feeding but colostrum would do so in three hours. The rise in agglutinins and globulins was parallel.

Ragsdale and Brody (86) considered the possibility of replacing colostrum in the diet by a mixture of milk and blood serum. In order to make the colostrum disease free they found it could be done in a water bath at 140 F. for 20 minutes. This destroyed the tubercle bacillus but did not coagulate the colostrum unless the heating was continued for three hours. They also discovered that colostrum could not be heated much above that temperature without destruction of the immunizing bodies contained in it.

The literature in this field has been reviewed by Gamble and co-workers (39). They have further explored the possibility of using mixtures of sera and milk as substitutes for colostrum in feeding foals and lambs. These substitutes were only partly satisfactory. The best results were obtained by using blood sera of the same species.

#### The Anti-Body Effect of Colostrum

According to Savage and McCay (96) the first real evidence that colostrum was an important factor in the immunization of young animals originated in the attempts of Ehrlick to transmit immunity by inheritance. Before the time of Ehrlick (1892), it was known that the young might become immune to certain diseases if the mother had acquired such immunity. Ehrlick immunized mice against toxic proteins and then removed the young at birth from immunized to normal mothers. The young of immunized mothers had no immunity to the poisons. The mice allowed to suckle immune mothers had a limited immunity. This indicated that the immunity had been transferred primarily through the

mammary gland with possibly some little transfer through the placenta. In this report Ehrlick also called attention to the dilution of the immune sera in the body of the young mouse due to the rapid growth during the first days of life.

Ragsdale and Brody (86, 87) stated that one fundamental difference between colostrum and milk is the immune body content. It is well known that after certain infectious diseases, for example, typhoid fever in man, there are immune bodies known as anti-bodies which serve to protect against re-infection. These bodies may be determined qualitatively and quantitatively by biological methods. Colostrum is known to be very rich in all types of immune bodies found in the blood of the mother. The immune bodies like the globulin, seem to pass unchanged from the blood through the mammary glands.

They stated another significant fact that the blood of the newly born calf contains neither globulin nor immune bodies. Neither of these substances are found in the blood of the calf after a feeding of normal milk. If, however, the newly born calf is given a feed of colostrum and then the blood serum tested, it is found to contain both globulin and immune bodies. In other words, the globulin and immune bodies pass from the blood of the mother into the blood of the off-spring unchanged in their passage through the mammary gland of the mother and through the alimentary tract of the young mammal.

According to Ragsdale and Brody (86, 87), the globulin and immune bodies seem to travel together and change together. If the

globulin is separated from the blood serum it is found that practically all of the immune bodies remain with the globulin fraction. During infectious diseases when the immune body content of the blood rises, there is also a rise in globulin. The concentration of immune bodies in colostrum is proportional to the concentration of globulin in the colostrum.

Calves that do not get colostrum are much more subject to infectious diseases, particularly scours, than calves that do receive colostrum.

The immune bodies passing from the mother to the offspring by way of colostrum are of the passive or transitory type. The concentration of these bodies in the blood of the young calf gradually diminishes, but while these passively transmitted immune bodies are diminishing, the young animal is gradually developing its own active defense or immunizing mechanism. The benefits of the colostrum, while transitory, are evidently very important during the period of life when the animal is without its own defense mechanism.

Since the distinctive feature of colostrum is its large globulin and immune body content, it seems clear that there is only one other substance that contains these which could therefore replace colostrum in part, and that is blood serum.

Hansen and Phillips (47) reported that the serum of the new born calf contains small amounts of proteins immunologically similar to colostrum "immune" proteins. An increase in serum "immune" proteins of the young calf resulted from the ingestion of normal milk.

### Vitamin A and Carotene

The importance of colostrum as a source of fat soluble vitamins has been recognized in recent years. In 1932, Dann (20) recognized that young rats were born with a poor supply of vitamin A, and suggested the colostrum might have importance in providing an early supply. The colostrum of the cow was known to be 10 to 100 times as rich in this fat soluble vitamin as ordinary milk.

Several workers (43, 49, 70, 82, 87, 97) found that in spite of the fact that the calf is born with a very poor reserve of vitamin A, it seems able to survive upon low levels of this vitamin until it can eat hay, if it is allowed to start life by consuming the colostrum, and building an initial reserve of this factor. Although experiments from several laboratories indicated clearly as early as 1913 that vitamin A deficiency would often destroy the eye before the animal died, this subject was given little attention until about 10 years later by those concerned with feeding calves.

The indispensable nature of vitamin A in the ration of dairy calves was shown by Jones, Eckles and Palmer (60) as early as 1926. To provide a vitamin A free diet these workers treated whole milk with hydrogen peroxide and then bubbled oxygen through it. Skimmed milk was freed of vitamin A by bleaching it in the sunshine. In summer the calves were left in the sunshine and in the winter, Vitamin D was furnished by cod-liver oil freed of vitamin A. If their diet contained 40 per cent wheat straw, the calf could grow normally. Assays with rats showed that 35 per cent of this straw provided the

rat with adequate vitamin A. The time for the calves to break down physically ranged from 2 to 6 months. The many symptoms that accompanied this physical decline included failure to grow, pneumonia, nephritis, sclerosis of the liver, and necrosis of the rumen, and blindness. The daily feeding of 20 ml. of cod-liver oil furnished adequate vitamin A. These results indicate that the calf needs less than 16,000 International Units of vitamin A per day.

Keener and co-workers (61) reported that the minimum carotene requirement of dairy calves maintained at an environmental temperature of 50 to 70 F., to be approximately 12 micrograms per day per pound of body weight. The minimum carotene requirement for growth and well-being of dairy calves appears to depend upon environmental temperature. During severe winter weather the minimum requirement may be more than twice as much as during warm weather. This increased requirement is substantiated by the observed lowering of blood carotene and blood vitamin during cold weather. Respiratory and bowel disturbances are more prevalent during periods of low blood vitamin A than when the store of blood vitamin A is more abundant. Histopathological studies revealed that calves receiving a carotene intake of less than 27 micrograms per pound of body weight per day may not be fully protected when subjected to average winter conditions. It is highly probable that such histopathological changes exist in calves raised in regions where roughages of poor quality are fed, and that these conditions may affect the productive efficiency and reproductiveness of the dairy cattle of such regions.

Bechdel, Eckles and Palmer (7) reported the indispensable nature of vitamin A in the ration of dairy calves. Hart and Guilbert (49) found that a vitamin A deficiency developed in cattle under range conditions during unusually long seasons of dry feeding. Guilbert and Hart (44) reported that 26 to 33 micrograms of carotene from alfalfa per day per kilogram of body weight was sufficient to prevent or cure vitamin A deficiency in cattle. Guilbert, Miller, and Hughes (42) also reported the minimum carotene requirement for cattle, sheep and swine to be between 25 and 30 micrograms per day per kilogram of body weight. The vitamin A requirement was found to be six to eight micrograms daily per kilogram of body weight.

Moore (68, 69) found that a carotene intake of about 16 micrograms per pound of body weight per day was sufficient to maintain plasma carotene at 0.2 micrograms per ml. Nyctalopia and papillary edema were found to follow. Converse and Meigs (15) concluded that because of the greater susceptibility of calves to various calf ailments during the first three to four months of life, than at older ages, they need a more generous allowance of vitamin A than do older calves. These workers concluded that the California standard (44) is less than one-third of the optimum for calves between three and 180 days of age. Ward, Bechdel and Guerrant (118, 119) found that 11 micrograms of carotene from a carotene concentrate per pound of body weight per day, prevented vitamin A deficiency in Holstein calves. This requirement was also supplied by 14 micrograms of carotene from alfalfa hay or by 33 micrograms of carotene from alfalfa molasses silage. It was also

observed that the carotene requirements of some calves appeared to be slightly higher in cold weather than in moderate weather.

In 1928, the edema that accompanies vitamin A deficiency was studied further by Bechdel and co-workers (9). Reed and co-workers (90) found that blindness that developed in heifers fed cottonseed meal could be prevented by feeding more hay, thus increasing the vitamin A of the diet. Bechdel (10) also found that this blindness could be prevented by feeding 25 ml. of cod liver oil.

In 1924, both Hart and co-workers (50) and Eckles (33) noted that calves might be born dead or blind in cases where the cow had been maintained upon a diet deficient in vitamin A.

Mead and Regan (67) in rearing calves without cod liver oil found vitamin A deficiencies after about seven months, even though some whole milk was fed until the calves were six months old. In two to seven days their vitamin A deficient calves responded when fed cod liver oil.

Moore and Hallman (69) observed white spotted kidneys of calves fed diets deficient in vitamin A, and noted that they resembled kidneys found in calves that were deprived of colostrum. Moore (68) by means of the ophthalmoscope, observed a swelling or edema of the nerve head leading into the eye in calves fed a low intake of carotene. As a vitamin A deficient diet he fed skimmed milk and a grain mixture of barley, rolled oats, wheat bran, linseed oil meal, and salt. Calves 40 to 90 days of age fed on this ration showed signs of night blindness in 48 to 73 days. This could be cured in 5 to 18 days by

feeding a ration containing sufficient vitamin A. The plasma level of vitamin A might drop as low as 0.13 micrograms per cent. This was increased to 0.2 micrograms per cent by feeding 12 to 13 micrograms of carotene per pound of body weight.

Jones and co-workers (60) stated that vitamin A is present in large amounts in the liver of calves fed normal rations but is absent from livers of calves fed vitamin A deficient diets. Calves which were fed 28 micrograms of vitamin A daily were very thrifty and their plasma level was about 0.7 micrograms per cent. Holstein calves on pasture showed plasma levels as high as 15 micrograms per cent.

Guilbert and Hart (44) estimate the needs of cattle at about 29 micrograms of vitamin A per kilogram of live weight. They found carotene dissolved in olive oil injected subcutaneously relieved the eye symptoms in a vitamin A deficient calf, but in general recovery was very slow. Other workers (38, 118) have given a slightly lower requirement of 11 micrograms per pound of live weight. Early experience with diets very low in vitamin A indicates a calf can bridge the period between colostrum feeding and the consumption of hay with quite low allowances of vitamin A. Dahlberg and Maynard (17) found no evidence that the addition of a concentrate from cod-liver oil to furnish more vitamin A and D was advantageous when fed hay of good quality. Insko and Rupel (57) reported the addition of two per cent of cod liver oil to a good ration was of no advantage in rearing calves to six months of age.

A possible relationship between vitamins A and C was suggested by

King (63). He found that calved fed diets deficient in vitamin A so that the plasma value drops to 0.18 micrograms per cent, also exhibit a parallel drop in both the vitamin C of the blood and a decline in the excretion of this vitamin. Furthermore, the papillary edema described by Moore (68) was prevented by feeding carotene and injecting vitamin C, but not by either procedure alone. In as much as the calf is known to synthesize vitamin C, these interrelationships are of considerable importance since a deficiency of vitamin A might lead to two deficiencies. Eaton and co-workers (30) reported on the plasma levels of carotene and vitamin A in calves from dams milked prepartum and in calves from dams milked postpartum. They found no significant difference in the blood plasma levels of carotene and vitamin A at birth. However, for the remainder of the experimental period on calves one to four weeks of age, both the blood plasma carotene and vitamin A were significantly higher in the dams milked postpartum, compared to those values for the calves from dams milked prepartum. Prepartum milking results in significantly lower blood plasma levels of carotene and vitamin A in young calves.

Shephard and Converse (98) provided good illustrations of the effect of a deficiency in vitamin A in retarding the growth of calves. They concluded four to eight ml. of cod liver oil would meet the calf's need for vitamin A. When the colostrum is low in vitamin A, the young animal might profit considerably from some special supplement fed during the first few days of life. One worker (82) thought that this, in general, might be a profitable practice.

### Calcium and Phosphorus

Anderson and co-workers (3) compared the blood of normal calves under a month of age with those from one to five months of age. From their data the normal level of phosphorus is 4.5 milligrams per cent, and calcium, 12.4. Blood serum calcium is apparently 11 to 13 milligrams per cent for the normal calf from the data published by Duncan and Huffman (25).

One research worker (12) stated that calcium is the major mineral element in respect to quantity contained in the bodies and in the milk of cows. However, deficiencies of phosphorus among ruminants or herbivorous animals far outnumber deficiencies of calcium. As evidence of this situation, most countries have certain names or designations for phosphorus deficiency diseases. Pica, Styfasiekte, loin disease, creeps, stiffes, sweeny, peg-leg, cripples, are some of the terms used to designate a phosphorus deficiency.

## EXPERIMENTAL PROCEDURE

### Feeding and Management of the Cows

Forty-seven cows and heifers due to freshen from 1946 to 1951, were divided into four groups. Group I was a Holstein prepartum milked group, and Group II was a Holstein check group. Group III was a Jersey prepartum milked group, and Group IV was a Jersey check group. All cows and heifers in the experiment were put in a box stall in the barn seven days before the calculated freshening date so they would become acquainted with their surroundings and could be cared for and be available for milking and taking of blood samples. Beginning with the seventh day before the calculated freshening date, blood samples were taken from the jugular vein at 6.30 a.m. every other day for carotene, vitamin A and calcium and phosphorus determinations.

The prepartum milked group was milked twice a day beginning the seventh day before the calculated freshening date through the fourth day postpartum, which was the experimental period. The check group was milked twice daily four days postpartum. The time of milking was 5.30 a.m., and 5.30 p.m.

A composite colostrum sample was taken from all quarters for bacteriological study. To prevent or to avoid any external contamination during sampling the udder, teats and teat orifices were washed with tepid chlorine solution containing between 100 and 200 ppm of available chlorine. The first few streams of milk were discarded in order to flush out the organisms in the streak canal. This procedure was followed irregardless of the amount present in the udder.

In some instances, no colostrum remained after these first few streams were removed from the teat. The sample was collected in a clean, sterile screwcap vial, taken to the laboratory and plated within one hour. After the bacteriological sample was taken, the cow was milked out dry, massaging the udder during the milking process. Colostrum samples were also taken at every milking and analyzed for calcium, phosphorus, vitamin A and carotene content.

Each cow was fed three pounds of the herd concentrate mix at the time of milking. The concentrate mix for the year 1948 - 1949 was as follows :

	<u>Pounds</u>
Barley.....	385
Bran.....	200
Beet Pulp.....	300
Soybean meal.....	100
Bone meal.....	5
Salt.....	10
	<u>1000</u>

The protein content on the above ration was found by analysis to be 16.6 per cent. The concentrate mix for the year 1949 - 1950 was as follows :

	<u>Pounds</u>
Barley.....	285
Bran.....	200
Beet Pulp.....	325
Soybean meal.....	175
Bone meal.....	15
Salt.....	10
	<u>1000</u>

The protein content of the above ration was found by analysis to be 19.43 per cent.

Immediately after parturition the cow was given a warm bran mash and all of the warm water she would drink.

Daily records were kept of the physical condition of the udders and amounts and characteristics of secretion. Photographs were taken of the udders of all groups on the seventh day before the calculated freshening date, day of parturition and on the fourth day postpartum.

Colostrum which had been stored frozen was fed to calves from prepartum milked cows for four consecutive days. At the end of the fourth day all the calves were gradually put on Holstein herd milk.

The data obtained were analyzed according to standard statistical procedures (101).

#### The Determination of Blood Plasma Carotene and Vitamin A

The determinations of blood plasma, carotene and vitamin A contents were made by the method reported by Boyer and co-workers (13). They state that carotene and other carotenoids interfere in the determination of vitamin A by the Carr-Price reaction, and in the analysis of certain samples of cattle blood, nearly all of the observed color of the Carr-Price reaction may be due to the carotene present. Therefore, in order to determine the vitamin A correctly, it is necessary to separate the carotene from the vitamin A.

The Boyer method is based upon the different solubilities of carotene and vitamin A in 50 to 60 per cent ethyl alcohol. The carotene is precipitated from the alcohol solution by dilution, whereas vitamin A remains in solution.

The success of the experiments with pure vitamin A and carotene

solutions indicated that the method offered good possibilities as an aid to the determination of vitamin A in blood samples containing high concentrations of carotene.

In this method 10 ml. of 95 per cent ethyl alcohol and 24.0 ml. of petroleum ether are added to 10.0 ml. of plasma in a 50 ml. test tube fitted with a glass or cork stopper. The stopper is sealed in with mineral oil and the tube and contents shaken gently for ten minutes. The tubes are then placed in the refrigerator for an hour or more to obtain separation of the layers. A suitable aliquot portion of the petroleum ether extract (1 to 10 ml.) is diluted to 10.0 ml. with petroleum ether and the carotene estimated. If necessary, a 20.0 ml. aliquot, including that used for carotene estimation, is transferred to a 75 ml. Pyrex test tube. Two of these tubes are connected by means of a "Y" tube to a water suction pump and the solvent removed under a slowly increased vacuum, while the tubes are being shaken in a rotary manner. After a high vacuum is applied the tubes are heated in a water bath to a temperature not over 70 C. until the solvent is entirely evaporated. The test tube and contents are cooled in water, then the vacuum is released, and the residue dissolved immediately in 8.0 ml. of absolute ethyl alcohol. It was sometimes necessary to apply slight heat to facilitate solution of the residue. The carotene is precipitated and removed by filtration. Precipitated material other than carotene makes a sufficient amount of precipitate to provide good separation. The alcohol content of the filtrate is reduced to about 40 per cent by the addition of

distilled water. The filtrate is extracted by adding 13.0 ml. of petroleum ether and thoroughly shaking for ten minutes. A more complete separation of the ether layer is obtained by allowing the mixture to stand in the refrigerator for a short time. Ten ml. of the upper layer is then transferred to an Evelyn colorimeter tube. In most cases this layer was found to be mainly Xanthophylls. After evaluation of the Xanthophylls correction, the petroleum ether is removed under vacuum as before, the sample dissolved in 1.0 ml. of chloroform, and the vitamin A, determined by the Carr-Price reaction as is explained in the determination of milk vitamin A by Boyer, et al. (14).

#### The Determination of Blood Plasma Calcium

According to Koch (64) the calcium is present in blood in the ionic form in equilibrium with calcium proteinate and other calcium salts. By treatment with high concentration of trichloroacetic acid, all of the calcium is converted into a form which is so readily ionized that it can be precipitated quantitatively as oxalate. After separating and washing, the latter is treated with a special acid permanganate solution and the residual permanganate color measured photoelectrically (24). The method is carried out on blood plasma. It is customary to use heparinized or citrated blood (1.5 per cent sodium citrate) and to separate the corpuscles by centrifugation as soon as possible. Ten ml. of distilled water were added to five ml. of plasma in a dry, large test tube or small flask, and mixed well. Then five ml. of 20 per cent trichloroacetic acid solution was added drop by drop, agitating

during the addition, mixed thoroughly and allowed to stand for 30 minutes.

After standing one half hour, the mixture was filtered through a dry filter into a dry vessel. Ten ml. of the filtrate was transferred to 15 ml. centrifuge tubes which were thoroughly cleaned, sterilized and pre-rinsed with redistilled water. The material was transferred into these tubes which had an internal diameter of three to four mm. in a manner that did not allow the material to run down the sides of the tube. One ml. of 20 per cent sodium acetate solution was added. To this, six to eight drops of the bromocresol green indicator and one ml. of four per cent ammonium oxalate solution were added. The oxalate was dripped directly into the solution in the tube and then stirred with a very thin glass rod. Ammonium hydroxide was added until the tint was the same as that given by a buffer mixture of pH 5.0 with the same indicator. The solution was mixed well with the thin glass rod, and the rod rinsed with a few drops of distilled water. The solution was stoppered and set aside overnight. The next day the tubes were covered with rubber caps and centrifuged for ten minutes at 2300 revolutions per minute. The supernatant solution was removed by decantation. The entire sides of the tubes were washed down with two ml. of the saturated  $\text{CaC}_2\text{O}_4$  solution containing 0.5 per cent  $\text{NH}_4\text{OH}$ . The centrifuging and the decanting was repeated in the same way. The washing and decanting was repeated twice more, making a total of three washings.

The calcium oxalate precipitate was dissolved in a drop of 50 per

cent  $\text{HNO}_3$  and exactly ten ml. of the special acid ( $\text{N}/500 \text{KMnO}_4$ ) were added. After allowing to stand for at least 30 minutes, the color density was read (d) using a green filter. The color density of the  $\text{N}/500 \text{KMnO}_4$  solution (L) is also estimated by means of a photoelectric colorimeter with a green light filter with a maximum transmission at 520 mu.

The plasma calcium is given directly by the equation :

$$\text{Mg of Ca}/100 \text{ ml.} = K (L - d)$$

where K is a constant depending upon the construction of the apparatus and the color of the filter and the size of the plasma sample.

#### The Determination of Blood Plasma Phosphorus

According to Dann (18), Fiske and Subbarow stated that much has been written on the danger of loss of phosphate in various ways in the course of the wet ashing process of determining blood plasma phosphorus. They added that this danger is without the slightest doubt a real one, at least in the case of material difficult to digest. But when no such difficulty presents itself (e.g. in ashing protein free blood filtrates), Dann (18) was convinced that the loss is brought about by trying to digest with so little sulfuric acid that the tube is nearly dry and probably by unnecessary overheating.

In the determination of blood phosphorus, four volumes of a 10 per cent trichloroacetic acid was transferred to an Erlenmeyer flask. While the flask was being rotated gently, one volume of plasma was run in from a calibrated pipette. The mouth of the flask was closed with a clean, dry, rubber stopper and shaken vigorously for a few times and

then the contents were filtered through an ashless paper.

Five ml. of the filtrate was measured into a tube graduated at ten ml. To this was added one ml. of 2.5 per cent ammonium molybdate in 3 N sulfuric acid (molybdate II) and finally (after mixing) 0.4 ml. of the sulfonic acid reagent and diluted to 10 ml. The standard contained 5.00 milligrams of phosphorus per 100 ml. solution and was handled exactly like the plasma being analyzed.

The optical density reading (L) was made in about 5 minutes, but repeated a few minutes later if the color was particularly strong. The optical density reading (d) of the standard was also recorded. The results were calculated as follows :

$$\text{Mg phosphorus per 100 ml. plasma} = 5/d (L)$$

#### The Determination of Vitamin A and Carotene in Milk

The method used to determine vitamin A and carotene was that outlined by Boyer, Spitzer, Jensen and Phillips (14).

Thirty ml. of potassium hydroxide solution was added to 20 ml. of milk in a separatory funnel. After a brief vigorous shaking it was allowed to stand for three hours. At the end of the three hour period 25 ml. of diethyl ether was added to the funnel, stoppered tightly and the contents shaken vigorously for one minute. After the separation of the layers, the lower layer was drawn off into the second funnel, retaining any small emulsified material. The residue of the second funnel was extracted with 18 to 20 ml. of ether. Then the material was shaken vigorously for one minute. The vapor was allowed to escape through the stop-cock. After separation, the lower layer was discarded.

Seventy-five ml. of distilled water was added to the first separatory funnel and was inverted once. Then the water was drawn off after separation, into the material in the second funnel, shaken vigorously for one minute, again after separation the lower layer was drawn off and discarded.

The solution in the first funnel was washed with 10 ml. of acidified alcoholic wash solution, the funnel inverted three times and then the bottom layer was drawn off into the second funnel and it also was inverted three times. The bottom layer was then drained off and discarded.

Three ml. of petroleum ether was added to each funnel to reduce water content.

The extract of the first funnel was washed twice more with 10 ml. portions of acidified alcoholic wash solution, the acidified solution drawn off into the second funnel, inverted twice and discarded. After the third washing with the acidified wash solution, the solutions of the funnels are combined and allowed to stand for 15 to 20 minutes so the water can settle out, the last remains of water removed and the solutions drawn off into a 75 ml. Pyrex test tube.

The ether solvents were removed by attaching two test tubes to a vacuum pump by means of a Y tube. The vacuum was slowly increased with continual gentle rotary shaking of the inclined tubes in a 30 - 40 C. water bath until it is possible to apply high vacuum without excessive frothing of the sample. Finally, the tubes were heated in a 60 - 70 C. bath with continued shaking, just long enough to remove all solvents.

The tubes were cooled in cold water before the vacuum was released.

After the release of the vacuum, the residue was dissolved in 5 ml. of ether and the solution transferred to a suitable volumetric flask. To this, 5 ml. of concentrated salt solution was added and the solution made up to volume with petroleum ether. Ten ml. of this solution was transferred to an Evelyn colorimeter tube and the total carotenoids were measured using the 440 filter. The colorimeter tube was then attached to a vacuum pump and the solvent evaporated as before. The residue was dissolved in 1.0 ml. of chloroform. A drop of acetic anhydride was added to remove any trace of water. Then the tube was placed in the colorimeter with a shield such as a paper towel placed over the colorimeter to protect it from the reagent used, and 9.0 ml. of 20 volumes per cent antimony trichloride in chloroform added from a rapid delivery pipette. A reading was made immediately, using a 620 filter.

The calculations were made as follows : As recommended by Boyer (14) a constant was used for the calculations of carotene. The constant used was  $L_{440} \times 28 =$  micrograms of carotene per 10 ml. of skellysolve B.

The blue color produced by the Carr-Price reaction follows Beer's law and a constant was evaluated by standardizing the colorimeter with pure vitamin A. The constant used was  $L_{620} \times 13.2 =$  micrograms of vitamin A per 10 ml. of chloroform. For the calculation the vitamin A reading was corrected for the Carr-Price (14) reaction of carotenoids, using the correction factor of 0.14. The calculation then was

$(1620 - 0.14 D_{440}) \times 13.2 =$  micrograms of vitamin A per 10.0 ml.  
of chloroform.

#### The Determination of Milk Calcium

The milk calcium was determined by a modification of two methods (24, 64). The sample of milk was digested by measuring (tuberculin syringe) 0.40 ml. milk into a numbered Pyrex tube. To this was added 1.7 ml. of a digestion mixture consisting of 100 ml. of sulfuric acid, 200 ml. of nitric acid and 40 ml. of perchloric acid and a carborundum chip. This was digested slowly on a hot plate under the hood until it was a clear, colorless solution. After cooling, about 5 ml. of water was added along with a drop of phenolphthalein. It was then stirred with a gas stream while slowly adding 10 N. NaOH until a pink color appeared. It was then just reacidified with 4 N. sulfuric acid. This completed the digestion of the sample, which was then diluted to 10.0 ml.

Three ml. of this digested sample were pipetted into a 15 ml. centrifuge tube. Two ml. of buffered oxalate solution and two drops of brom cresol green indicator were then added followed by the addition of acetic acid until a blue green color appeared, stirring with gas while these additions were being made. After standing overnight, it was centrifuged for five minutes, drained and the precipitate loosened in a drop of aerosol. The precipitate was then washed down with 4 ml. of wash solution. The centrifuge was repeated and also the loosening and washing of the precipitate. After centrifuging for a third time and draining, the calcium-oxalate precipitate from the milk was dissolved

in a drop of 50 per cent  $\text{HNO}_3$  and exactly 10 ml. of  $\text{N}/500 \text{KMnO}_4$  were added. After allowing it to stand for at least 30 minutes, the color density was read (d) using a green filter. The color density of the  $\text{N}/500 \text{KMnO}_4$  solution (L) was also estimated by means of a photoelectric colorimeter with a green light filter with maximum transmission at 520 mu. The calcium was determined directly by the equation : Mg of calcium/100 ml. =  $K(L - d)$  where K is a constant depending upon the construction of the apparatus, the color of the filter and the size of the sample.

#### The Determination of Milk Phosphorus

The milk was digested in the same manner as in preparation for the determination of milk calcium.

One half ml. of the digested milk was measured into a test tube graduated at 10 ml. Added to this was 1 ml. of 2.5 per cent ammonium molybdate in 3 N sulfuric acid (molybdate II) and finally (after mixing) 0.4 ml. of the sulfonic acid reagent and diluted to 10 ml.

The standard contained 50.0 mg. of phosphorus per 100 ml. of solution and was handled exactly like the milk sample that was analyzed.

The optical density reading (L) was made after the mixture was allowed to stand at least 30 minutes. The optical density reading (d) of the standard was also recorded. The results were calculated as follows :

Mg. of phosphorus per 100 ml. of milk =  $50/d(L)$  or if calculated in per cent phosphorus : per cent phosphorus in milk =  $0.50/d(L)$ .

## DISCUSSION OF INDIVIDUAL COWS AND GROUPS

The detailed data on the individual cows in the various groups are presented in Tables I to XXXVII in the Appendix. These tables contain data on the amount of colostrum secreted in pounds per day, the blood plasma carotene, and vitamin A, the colostrum carotene and vitamin A in micrograms per cent. The blood plasma calcium and phosphorus are expressed in milligrams per cent. The colostrum calcium, and phosphorus, are expressed in per cent.

Cow No. 2 (Appendix, Table I), a seven year old Holstein in her fifth lactation, was premlked eight days and produced 1.4 pounds the eighth day prepartum to 12.4 pounds the day after freshening, to 43.3 pounds four days postpartum.

The blood plasma carotene content began at 1440 micrograms per cent on the seventh day prepartum and had a gradual downward trend to 1215 on the fourth day postpartum. The blood plasma vitamin A content varied from 10.8 to 17.6 micrograms per cent and had an upward trend from the seventh day prepartum to the fourth day postpartum.

The carotene content of the colostrum varied from 78 to 165 micrograms per cent with no set pattern or trend. The vitamin A content of the colostrum varied from 112 micrograms per cent on the eighth day prepartum to 89 on the fourth day postpartum.

The blood plasma calcium on the seventh day prepartum was 8.7 milligrams per cent. The first day prepartum it had lowered to 8.0 milligrams per cent and the second day postpartum it had lowered to 7.7, rising to 8.5 on the fourth day postpartum. The blood plasma phosphorus

on the seventh day prepartum contained 6.9 milligrams per cent and dropped to 3.1 the fourth day postpartum.

The calcium content of the colostrum began at a level of 0.125 per cent on the eighth day prepartum and reached a high of 0.178 per cent on the first day postpartum. It then began a downward trend and reached 0.153 per cent on the fourth day postpartum. The phosphorus content of the colostrum began at 0.114 per cent on the eighth day prepartum and reached 0.140 on the first day prepartum and 0.154 and 0.149 first and second days postpartum respectively. On the fourth day postpartum it had lowered to 0.120 per cent.

During the experimental period the udder of Cow No. 9 became very congested and sore, and secretion from all quarters contained blood at some time during the period. However, by the fourth day postpartum, all quarters were soft, pliable and spongy except the left rear quarter which still had some swelling in the lower part. The right front quarter produced very little secretion during the experimental period. On the fourth day postpartum this quarter secreted approximately 0.6 to 0.7 pounds of milk per milking. There was a very high bacteria count all through the experimental period.

Cow No. 15 (Appendix, Table II), a six year old Holstein, fifth lactation, was premlked eight days. She produced 1.0 pound of milk the sixth day prepartum and 51.2 pounds the fourth day postpartum. There was a steady increase in production during the experimental period.

The blood plasma contained 1750 micrograms per cent of carotene

the fifth day prepartum, and showed a steady decrease to 1440 on the fourth day postpartum. The blood plasma vitamin A reached a high the third day prepartum with a value of 17.8 micrograms per cent and then there was a steady decrease to the fourth day postpartum which showed a value of 8.3 micrograms per cent.

The carotene in the colostrum showed a value of 110 micrograms per cent the fifth day prepartum and then varied considerably, reaching a value of 90 the second day prepartum, from which there was a steady decrease until a value of 39 was obtained the fourth day postpartum. The vitamin A content of the colostrum varied considerably with no definite trend, reaching a high of 108 micrograms per cent the second day prepartum. The fourth day postpartum showed a value of 104 micrograms per cent. The blood plasma contained 11.7 milligrams per cent of calcium the fifth day prepartum, reaching a low of 9.2 the second day postpartum and increasing to 10.7 the fourth day postpartum. The blood plasma showed a value of 4.8 milligrams per cent of phosphorus the fifth day prepartum, reaching a low of 3.9 the fourth day postpartum. The trend was upward to the first day prepartum and then it showed a decline.

The calcium content in the colostrum varied from a high of 0.193 per cent the sixth day prepartum to a low of 0.062 the third day prepartum. There was no definite pattern or trend. The phosphorus content of the colostrum was 0.110 per cent the eighth day prepartum and reached a high of 0.180 the third day prepartum and declined to 0.120 on the fourth day postpartum. The udder was very soft and pliable

throughout the experimental period. Previous to and immediately following parturition, there was some swelling but no hardness. By the fourth day postpartum, the udder was perfectly normal. Large numbers of micro organisms were found in the colostrum during this time.

Cow No. 5 (Appendix, Table III), a nine year old Holstein in her seventh lactation, was premilked eleven days. She produced 1.0 pounds of milk the eighth day prepartum and showed a steady increase up to 74.4 pounds the third day postpartum.

The blood plasma carotene showed a downward trend beginning with a value of 1440 micrograms per cent the seventh day prepartum and 710 the fourth day postpartum. The blood plasma vitamin A varied from a high of 52.5 micrograms per cent on the fifth day prepartum to a low of 9.2 on the fourth day postpartum.

The carotene in the colostrum varied from a high of 234 micrograms on the third day prepartum to a low of 63 on the fourth day postpartum. The vitamin A content of the colostrum varied from a high of 190 micrograms per cent reached on the fourth day prepartum to a low of 57 on the second day postpartum. There was no definite pattern or trend in the vitamin A content of the colostrum. The blood calcium and phosphorus were not determined.

The calcium content of the colostrum showed a steady increase from a low of 0.068 per cent the eleventh day prepartum up to a high of 0.229 the fourth day prepartum and then declined to 0.144 the fourth day postpartum. The phosphorus content of the colostrum showed

essentially the same trend beginning with a low of 0.050 per cent the eleventh day prepartum and increased to a high of 0.195 on the fourth day prepartum, then it steadily decreased to 0.125 per cent the fourth day postpartum.

This cow was somewhat slow about secreting her milk at first. The largest increase in amount of milk flow occurred the eighth day prepartum. Her udder was very soft and pliable throughout the experimental period. It was in excellent condition on the fourth day postpartum. The number of organisms were relatively few during the experimental period.

Cow No. 10 (Appendix, Table IV) was a six year old Holstein in her fifth lactation. She was premilked seven days and produced from 1.6 pounds of colostrum the seventh day prepartum up to 57.5 pounds the fourth day postpartum.

There were no blood or milk samples analyzed from this cow.

During the experimental period there was some congestion in the left rear quarter, but by the fourth day postpartum the udder was completely free of congestion. There were very few micro organisms found during the experimental period.

Cow No. 12 (Appendix, Table V), was a six year old Holstein. She was premilked 16 days in her fifth lactation, and produced up to 55.8 pounds of colostrum on the fourth day postpartum.

The blood plasma carotene showed a downward trend from 360 micrograms per cent the fifth day prepartum to 160 the fourth day postpartum. The blood plasma vitamin A decreased from 26.0 micrograms per cent the

seventh day prepartum down to 8.5 the second day postpartum, and then increased to 12.5 the fourth day postpartum.

The carotene content of the colostrum varied from a high of 98 micrograms per cent the first day prepartum to a low of 30 on the fourth day postpartum. The vitamin A content of the colostrum also varied considerably, with a high of 97 micrograms per cent the first day to a low of 49 the fourth day postpartum.

The blood plasma calcium decreased from 12.1 milligrams per cent the ninth day prepartum to 6.3 the first day prepartum and then increased to 18.4 the fourth day postpartum. The blood plasma phosphorus decreased from 4.5 milligrams per cent the fifth day prepartum to 1.5 the second day postpartum and then increased to 2.2 the fourth day postpartum.

The calcium content of the colostrum varied from a low of 0.161 per cent the tenth day prepartum to a high of 0.198 per cent the fourth day prepartum and showed a downward trend from the second day postpartum. The phosphorus content of the colostrum varied from a high of 0.188 per cent the first day prepartum and the first day postpartum to a low of 0.128 the fourth day postpartum.

The udder contained some congestion during the experimental period and on the fourth day postpartum the udder still was swollen and some hardness was apparent. Very few organisms were found during this time.

Cow No. 35 (Appendix, Table VI), a four year old Holstein, was premilked sixteen days in her third lactation. She produced from 0.9

pounds the tenth day prepartum to 67.4 pounds the fourth day postpartum.

The blood plasma carotene content varied from a high of 280 micrograms per cent the seventh day to a low of 180 on the first day prepartum. The blood plasma vitamin A varied from a high of 20.0 micrograms per cent the seventh day prepartum to a low of 11.0 reached the third and fifth day prepartum respectively, and the same amount on the second day postpartum.

The carotene content of the colostrum showed a decrease from 41 micrograms per cent the first day to 25 the fourth day postpartum. The vitamin A content of the colostrum also showed a decrease from 47 micrograms per cent the first day to 28 the fourth day postpartum.

The blood plasma calcium varied from a high of 14.6 milligrams per cent on the third day prepartum to a low of 9.7 which was reached the first day prepartum. The blood plasma phosphorus varied from a high of 4.9 milligrams per cent on the seventh day prepartum to a low of 1.5 reached the fourth day postpartum.

The calcium content of the colostrum varied considerably decreasing from a high of 0.217 on the eighth day prepartum to a low of 0.180 per cent on the first day postpartum. The phosphorus content of the colostrum also varied considerably with a low of 0.090 per cent on the fourth day postpartum to a high of 0.200 on the eighth day prepartum.

The udder became swollen as she secreted her milk but by the fourth day postpartum it was very soft and pliable again.

Cow No. 54 (Appendix, Table VII), a three year old Holstein in

her third lactation, premilked five days, produced from 1.5 pounds of colostrum the fifth day prepartum which increased to 55.4 pounds on the fourth day postpartum.

The blood plasma carotene varied from a high of 255 micrograms per cent the third day prepartum to 195 the first day prepartum with no set pattern or trend. The blood plasma vitamin A decreased from 20.0 micrograms per cent on the fifth day prepartum to 7.0 the second day postpartum.

The carotene content of the colostrum showed an upward trend to 137 micrograms per cent the first day postpartum and then a decrease to 27 the fourth day postpartum. The vitamin A content of the colostrum increased to 104 micrograms per cent the second day prepartum then after a decrease, jumped to 185 the first day postpartum, and then decreased to 46 on the fourth day postpartum.

The blood plasma calcium decreased from 12.1 milligrams per cent the fifth day prepartum to 4.9 the second day postpartum. The blood plasma phosphorus increased from 4.0 milligrams per cent the fifth day prepartum to 5.1 on the first day prepartum and then dropped to 2.4 the second day postpartum.

The calcium content of the colostrum increased to 0.220 per cent the third day prepartum, and then began a downward trend the second day postpartum, showing, a slight increase to 0.160 per cent the fourth day postpartum. The phosphorus content of the colostrum increased to a high of 0.190 per cent the third day prepartum and then began a downward trend the first day prepartum and showed a value of 0.105 per cent

the fourth day postpartum.

The udder became quite congested during the experimental period but was somewhat relieved by the fourth day postpartum.

Cow No. 20 (Appendix, Table VIII), a five year old Holstein, third lactation, premilked six days, produced from 5.4 pounds of colostrum the sixth day prepartum up to 39.8 pounds the fourth day postpartum.

There were no blood or milk samples analyzed from this cow.

The udder was considered normal throughout this period. The fourth day postpartum, the udder was found to be very soft and pliable with no signs of congestion. Large numbers of organisms were found in the colostrum during this time.

Cow No. 71 (Appendix, Table IX), a two year old Holstein, first lactation, premilked two days, produced from 14.0 pounds of colostrum the second day prepartum up to 42.0 pounds the fourth day postpartum.

There were no blood or milk samples analyzed from this cow.

The udder was very congested at the beginning of the experimental period. However, by the fourth day postpartum, it was greatly relieved. There were a large number of organisms found in the colostrum from this cow.

Cow No. 67 (Appendix, Table X), a two year old Holstein in her first lactation, was premilked five days. She produced 5.4 pounds of colostrum the fifth day prepartum which increased up to 45.1 pounds the third day postpartum.

The blood plasma carotene varied from 420 micrograms per cent the fifth day prepartum to 270 the second day prepartum. The blood plasma vitamin A decreased from 22.0 micrograms per cent the fifth day prepartum to 5.0 the fourth day postpartum.

The carotene content of the colostrum decreased from 281 micrograms per cent the fourth day prepartum to 26 the fourth day postpartum. The vitamin A content of the colostrum decreased from 334 micrograms per cent the fourth day prepartum to 31 the fourth day postpartum.

The blood plasma content varied from a high of 11.6 milligrams per cent on the third day prepartum to a low of 6.8 on the second day postpartum. The blood plasma phosphorus varied from 5.1 the second day to 2.4 milligrams per cent the fourth day postpartum.

The calcium content of the colostrum decreased from 0.227 per cent the fifth day prepartum to 0.141 per cent the fourth day postpartum. The phosphorus content decreased from 0.242 the fifth day prepartum to 0.143 per cent the second day prepartum and then increased to 0.186 the fourth day postpartum.

The udder was very congested and blood was found in the colostrum during the experimental period. However, by the fourth day postpartum the milk appeared normal and the congestion was greatly relieved.

Cow No. 47 (Appendix, Table XI), a three year old Holstein, premilked six days in her third lactation. She produced from 3.7 pounds of colostrum the sixth day prepartum, which increased to 62.9 pounds the fourth day postpartum.

The blood plasma carotene decreased from 363 the fifth day prepartum to 190 micrograms per cent the fourth day postpartum. The blood plasma vitamin A was not determined.

The carotene content of the colostrum decreased from 190 micrograms per cent the sixth day prepartum to 31 the fourth day postpartum. The vitamin A content of the colostrum varied from 195 micrograms per cent the fifth day prepartum to 140 the first day prepartum and then decreased to 60 the fourth day postpartum.

The blood plasma calcium decreased from 10.4 milligrams per cent the fifth day prepartum to 8.7 the second day, and then increased to 10.7 the fourth day postpartum. The blood plasma phosphorus decreased from 3.8 milligrams per cent to 2.1 the second day postpartum and then increased to 2.7 on the fourth day postpartum.

The calcium content of the colostrum decreased from 0.201 per cent the third day prepartum to 0.083 the third day postpartum and then increased to 0.128 the fourth day postpartum. The phosphorus content of the colostrum varied from 0.078 per cent the sixth day prepartum up to 0.121 the second day prepartum and then decreased to 0.091 per cent the fourth day postpartum.

The udder became very congested with the right front quarter having a hard mealy spot at the top of the teat. By the fourth day postpartum, all quarters were normal except the right front. It still retained the hard spot which was somewhat smaller.

Cow No. 102 (Appendix, Table XII), a two year old Holstein in her first lactation was premlked six days. She produced up to 32.4

pounds of colostrum on the fourth day postpartum.

The blood plasma carotene increased from 130 micrograms per cent up to 19% on the first day prepartum, and then decreased again to 14% the fourth day postpartum. The blood plasma vitamin A decreased from a high of 30.0 micrograms per cent the seventh day prepartum to a low of 16.0 one day prepartum and then increased to 18.0 on the fourth day postpartum.

The carotene content of the colostrum decreased from 200 micrograms percent the fifth day prepartum to 22 the fourth day postpartum. The vitamin A content of the colostrum varied from 155 micrograms per cent the third day prepartum to 23 the fourth day postpartum.

The blood plasma calcium varied from a high of 13.1 milligrams per cent the fifth day prepartum to a low of 8.6 the second day postpartum. The blood plasma phosphorus content varied from a high of 6.0 to a low of 5.2 milligrams per cent the third day prepartum. There was no definite trend in these two constituents.

The calcium content of the colostrum varied from 0.198 per cent the fifth day prepartum to a low of 0.139 per cent on the second and third days postpartum. The phosphorus content of the colostrum decreased from 0.150 per cent the fifth day prepartum to 0.107 per cent the first day postpartum, and then increased to 0.120 per cent on the fourth day postpartum.

The udder was very congested throughout the period. By the fourth day postpartum the congestion had been relieved somewhat, but was still very congested. The bacteria count ranged from a low of

less than 3000 per ml. to 70,500 per ml. during the experimental period.

Cow No. 12 (Appendix, Table XIII), a seven year old Holstein in her sixth lactation, premilked four days produced up to 55.2 pounds of colostrum on the fourth day postpartum.

The blood plasma carotene varied from a high of 360 micrograms the first day prepartum to a low of 270 the second day postpartum. The blood plasma vitamin A decreased from 11.0 the third day prepartum to 2.0 micrograms per cent the second day postpartum and then increased to 10.0 micrograms per cent by the fourth day postpartum. The vitamin A content of the colostrum varied from a low of 52 micrograms per cent the third day prepartum to a high of 124 the first day postpartum. There was no set trend in this constituent.

The blood plasma calcium increased from a low of 7.6 milligrams per cent the first day prepartum to 9.8 the fourth day postpartum. The blood plasma phosphorus varied from a low of 3.5 the first day prepartum to a high of 4.9 milligrams on the second day postpartum.

The calcium content of the colostrum varied from a high of 0.187 per cent the fourth day prepartum to a low of 0.174 the first day postpartum. The phosphorus content showed an increase from 0.125 the fourth day prepartum to 0.144 per cent the first day postpartum. The analysis of these two constituents was not made for the last three days because the containers broke, loosing the samples.

The udder was very congested during this period and the colostrum contained blood. . By the fourth day postpartum the front quarters

were free of congestion but the rear quarters were still somewhat congested. A bloody colostrum was still being obtained from the rear quarters. The bacteria count ranged from a high of more than 300,000 to a low of 29,000 ml.

Cow No. 54 (Appendix, Table XIV) a four year old Holstein, fourth lactation, premilked three days produced up to 56.3 pounds of colostrum the fourth day postpartum.

The blood plasma carotene varied from a high of 220 micrograms per cent the first day prepartum to a low of 190 the fourth day postpartum. The blood plasma vitamin A decreased from 18.0 micrograms per cent the third day prepartum to 3.0 the second day postpartum and then increased to 11.0 the fourth day postpartum.

The carotene content of the colostrum varied from a high of 113 micrograms per cent the second day postpartum to a low of 51 the fourth day postpartum. The vitamin A content of the colostrum also varied from a high of 147 the second day postpartum to a low of 72 micrograms per cent on the fourth day postpartum.

The blood plasma calcium increased from 9.5 milligrams per cent the third day prepartum to 10.9 the fourth day postpartum. The blood plasma phosphorus level varied from a high of 5.9 the second day to a low of 5.2 milligrams per cent the fourth day postpartum.

The calcium content of the colostrum decreased from 0.295 per cent the second day prepartum to 0.115 per cent the fourth day postpartum. The phosphorus content of the colostrum decreased from 0.204 the first day prepartum to 0.094 per cent the fourth day postpartum.

The udder was very congested as parturition time approached. By the fourth day postpartum all quarters were free of congestion except the left rear which still had a swollen spot. Milk which was apparently normal was secreted. The bacteria count varied from a low of less than 3000 per ml. to more than 300,000 during the experimental period.

Cow No. 35 (Appendix, Table XV), a Holstein cow six years of age in her fourth lactation, was premilked six days. She produced up to 74.6 pounds of colostrum on the fourth day postpartum.

The blood plasma carotene decreased from 530 micrograms per cent the ninth day prepartum to 390 the fourth day postpartum. The blood plasma vitamin A varied from a low of 15.0 the first day prepartum to a high of 20.0 micrograms per cent the second day postpartum with no definite trend.

The carotene content of the colostrum decreased from the fifth day prepartum with a value of 290 to 28 micrograms per cent the fourth day postpartum. The vitamin A content of the colostrum decreased from 148 the fifth day prepartum to 47 micrograms per cent the fourth day postpartum.

The blood plasma calcium varied from a high of 9.8 milligrams per cent the third day prepartum to a low of 7.4 the first day prepartum. The blood plasma phosphorus increased up to 4.0 milligrams per cent the third day prepartum and then dropped to 1.9 the first day prepartum, then increased to 4.0 the fourth day postpartum.

The calcium content of the colostrum increased up to 0.272 per cent

the third day prepartum and then decreased to 0.152 the fourth day postpartum. The phosphorus content of the colostrum increased up to 0.171 per cent the third day prepartum and then decreased to 0.119 the fourth day postpartum.

The bacteria count was very high at all times during the experimental period, the count ranging from 36,000 to more than 300,000 per ml.

The udder became very congested the first day after parturition, but by the fourth day postpartum the congestion had been relieved considerably.

Cow No. 134 (Appendix, Table XVI), a two year old Holstein in her first lactation, was premilked ten days. She produced up to 40.2 pounds of colostrum on the fourth day postpartum.

The blood plasma carotene varied from a high of 590 micrograms per cent the ninth day prepartum to a low of 300 the first day prepartum with no set trend. The blood plasma vitamin A decreased from 36.0 the ninth day prepartum to 10.0 micrograms per cent the second day postpartum and then increased to 13.0 the fourth day postpartum.

The carotene content of the colostrum varied from a high of 178 micrograms per cent the ninth day prepartum to a low of 28 the first day prepartum, with no set pattern or trend. The vitamin A content of the colostrum decreased from 200 micrograms per cent the ninth day prepartum to 32 the third day postpartum.

The blood plasma calcium decreased from 10.7 milligrams per cent the seventh day prepartum to 7.8 the second day postpartum and then

increased to 9.7 the fourth day postpartum. The blood plasma phosphorus ranged from a high of 4.0 the third day prepartum to a low of 1.9 microgram per cent the first day prepartum.

The calcium content of the colostrum decreased from 0.250 per cent the ninth day prepartum to 0.130 the fifth day prepartum and then increased to 15.0 the first day postpartum and then decreased to 0.140 per cent again the fourth day postpartum. The phosphorus content of the colostrum varied from a high of 0.200 the ninth day prepartum to a low of 0.100 per cent the fifth day prepartum with no definite trend.

The udder became very congested as parturition time approached, but by the fourth day postpartum the udder was practically free from congestion. The bacteria count was less than 3000 per ml. throughout the experimental period.

Cow No. 14 (Appendix, Table XVII), a nine year old Holstein in her sixth lactation, was pre-milked five days. She produced up to 70.2 pounds of colostrum the second day postpartum, decreasing to 57.6 pounds on the fourth day postpartum.

The blood plasma carotene decreased from 590 the fifth day prepartum to 375 micrograms per cent the fourth day postpartum. The blood plasma vitamin A decreased from 23.0 the fifth day prepartum to a low of 8.0 the second day postpartum, then increased to 9.0 micrograms per cent the fourth day postpartum.

The carotene content of the colostrum varied from a high of 190 micrograms per cent the fourth day prepartum to a low of 24 the

first day prepartum, then increased to 53 the second day and decreased to 41 micrograms per cent the third day postpartum. The vitamin A content of the colostrum decreased from 143 the fourth day prepartum to 52 micrograms per cent the second day prepartum, then increased to 70 the first day prepartum and again decreased to a low of 34 micrograms per cent the third day postpartum.

The blood plasma calcium decreased from a high of 9.9 milligrams per cent the fifth day prepartum to a low of 9.0 the first day prepartum. The blood plasma phosphorus decreased to a low of 1.3 the second day prepartum then increased to 2.8 milligrams per cent the fourth day postpartum.

The calcium content of the colostrum decreased from 0.280 per cent the fourth day prepartum to a low of 0.130 the third day postpartum, then increased to 0.160 per cent the fourth day postpartum. The phosphorus content of the colostrum decreased from 0.200 per cent the third day prepartum to a low of 0.080 the third day postpartum, then increased to 0.120 per cent the fourth day postpartum.

There was some congestion as parturition neared, but by the fourth day postpartum the udder was completely free of congestion and was very soft and pliable. She retained her placenta which had to be removed the second day after parturition. The bacteria count ranged from a low of 23,000 to a high of 672,000 per ml.

Gow No. 91 (Appendix, Table XVIII), a three year old Holstein in her second lactation, was premilked five days. She produced up

to 46.7 pounds of milk the fourth day postpartum.

The blood plasma carotene decreased from 300 micrograms per cent the fifth day prepartum to 230 the fourth day postpartum. The blood plasma vitamin A varied from a high of 20.0 micrograms per cent the third day prepartum to a low of 12.0 the second day postpartum, then it increased to 16.0 micrograms per cent the fourth day postpartum.

The blood plasma calcium varied from a low of 10 milligrams per cent the third day prepartum to 11.3 the fourth day postpartum. The blood plasma phosphorus varied from a low of 3.2 milligrams per cent the fifth day prepartum to a high of 3.9 the second day postpartum. The variation in amounts of these blood constituents was not uniform.

The calcium content of the colostrum varied from a high of 0.190 per cent the fourth day prepartum to a low of 0.160 the second day postpartum, and then increased to 0.170 the third day postpartum. The phosphorus content of the colostrum increased from 0.140 per cent the fourth day to 0.160 per cent the first day prepartum, then it decreased to 0.150 per cent the first day postpartum. This value was maintained for the balance of the postpartum period.

There was no congestion of the udder at any time during this experimental period. The bacteria count varied from a low of 3000 to a high of 21,000 per ml.

Cow No. 60 (Appendix, Table XIX), a four year old Holstein in her third lactation, was premilked six days. She increased up to 64.4 pounds of colostrum on the fourth day postpartum.

The blood plasma carotene decreased from 425 micrograms per cent the fifth day to 410 the third day prepartum. Then it increased to 425 the second day postpartum. The blood plasma vitamin A increased from 20.0 micrograms per cent the fifth day to 23.0 the third day prepartum, then it decreased to 20.0 the fourth day postpartum.

The carotene content of the colostrum increased to 154 the first day prepartum, then decreased to 81 micrograms per cent the fourth day postpartum. The vitamin A content of the colostrum increased to 97 micrograms per cent the first day prepartum and then varied in amount until the fourth day postpartum, at which time it was 52 micrograms per cent.

The blood plasma calcium increased to 11.1 milligrams per cent the fourth day postpartum. The blood plasma phosphorus varied from a high of 4.0 milligrams per cent the fifth day prepartum to a low of 1.9 the second day postpartum. There was a very slight increase to 2.0 milligrams per cent the fourth day postpartum.

The calcium content of the colostrum showed an upward trend to 0.200 per cent the second day prepartum and then decreased to 0.130 the third day postpartum. The phosphorus content of the colostrum increased up to 0.160 per cent the fourth day prepartum, maintaining this value until the first day postpartum and then decreased to 0.120 the fourth day.

The udder became somewhat congested after parturition. On the fourth day postpartum very little congestion remained in the udder. The bacteria count varied from a low of 3000 to a high of 18,500 per

ml. during the experimental period.

Cow No. 41 (Appendix, Table XX), a four year old Holstein in her third lactation, was used as a check cow. She produced up to 46.5 pounds of colostrum the fourth day postpartum.

There were no blood or milk analyses made on this cow.

The udder was very hard and full and congested during the postpartum period. On the fourth day postpartum it was only slightly relieved.

Cow No. 5 (Appendix, Table XXI), a nine year old Holstein in her seventh lactation was used as a check cow. She produced up to 56.0 pounds of colostrum on the fourth day prepartum.

There were no blood or milk analyses made from this cow.

The udder was very congested during the postpartum period.

Cow No. 67 (Appendix, Table XXII), a three year old Holstein in her second lactation, was used as a check cow. She produced 26 pounds of colostrum the first day postpartum and increased to 44.9 pounds the fourth day.

The blood plasma carotene decreased from 360 micrograms per cent the third day prepartum to 170 the first day prepartum, and then increased to 320 the fourth day postpartum. The blood plasma vitamin A varied from a low of 16.0 micrograms per cent the first day prepartum to a high of 26.0 the second day postpartum.

The carotene content of the colostrum decreased from 204 micrograms per cent the first day postpartum to 44 the fourth day postpartum. The vitamin A content of the colostrum also decreased from 125 the

first day to 27 micrograms per cent the fourth day postpartum.

The blood plasma calcium decreased from 13.3 milligrams per cent the third day to 10.2 the first day prepartum, and then increased to 13.6 the fourth day postpartum. The blood plasma phosphorus decreased from 4.1 milligrams per cent the third day prepartum to 3.4 the fourth day postpartum.

The calcium content of the colostrum varied from a high of 0.149 per cent the first day to a low of 0.127 the third day postpartum. The phosphorus content of the colostrum decreased from 0.165 the first day to 0.13 per cent the fourth day postpartum.

There was very little congestion in the udder at any time and by the fourth day postpartum the udder was completely free of congestion and was very soft and pliable. The bacteria count decreased from a high of 65,000 the first day postpartum to less than 3000 the following day, then remained low during the remainder of the experimental period.

Cow No. 106 (Appendix, Table XXIII), a two year old Holstein in her first lactation, was used as a check cow and produced up to 28.0 pounds of colostrum the fourth day postpartum.

The blood plasma carotene increased up to 255 micrograms per cent by the fourth day postpartum. The blood plasma vitamin A varied from a low of 14.7 the second day to 24.7 micrograms per cent the fourth day postpartum.

The carotene content of the colostrum decreased from 111.0 micrograms per cent the first day to 40.0 the fourth day postpartum. The vitamin A content of the colostrum decreased from 178 micrograms per

cent the first day to 43 the fourth day postpartum.

The blood plasma calcium increased from 8.4 milligrams per cent the first day prepartum to 9.0 the fourth day postpartum. The blood plasma phosphorus varied from a low of 3.5 milligrams per cent the second day to a high of 5.7 per cent the fourth day postpartum.

The calcium content of the colostrum decreased from 0.184 per cent the first day to 0.139 the second day postpartum, and then increased to 0.152 the fourth day postpartum. The phosphorus content of the colostrum decreased from 0.148 per cent the first day to 0.128 the second day and then increased to 0.136 the fourth day postpartum.

The udder was very congested at the time of parturition. On the fourth day postpartum some congestion remained but it was greatly reduced. The bacteria count on this cow ranged from a low of 3000 to a high of 5000 per ml.

Gow No. 108 (Appendix, Table XXIV), a two year old Holstein in her first lactation, was a check cow. She produced up to 27.0 pounds of colostrum on the fourth day postpartum.

The blood plasma carotene increased from 190 micrograms per cent the second day to 195 the fourth day postpartum. The blood plasma vitamin A increased from 13.1 micrograms per cent the first day postpartum to 16.5 the fourth day postpartum.

The carotene content of the colostrum decreased from 125 micrograms per cent the first day to 32 the fourth day postpartum. The

vitamin A content of the colostrum decreased from 201 micrograms per cent the first day to 30 the fourth day postpartum.

The blood plasma calcium increased from 8.0 milligrams per cent the second day to 8.8 the fourth day postpartum. The blood plasma phosphorus decreased from 5.2 milligrams per cent the second day to 4.8 the fourth day postpartum.

The calcium content of the colostrum decreased from 0.130 per cent the first day to 0.119 the third day postpartum. The phosphorus content of the colostrum decreased from 0.130 the first day to 0.109 per cent the fourth day postpartum.

The udder was very congested during this period, but had been relieved somewhat by the fourth day postpartum. It was discovered that the left front quarter was blind. The bacteria count ranged from a high of 351,000 down to less than 3000 per ml. during this period.

Cow No. 138 (Appendix, Table XXV), a two year old Holstein in her first lactation, was a check cow, and produced up to 31.4 pounds of colostrum the fourth day postpartum.

The blood plasma carotene decreased from 610 micrograms per cent the fifth day prepartum to 350 the fourth day postpartum. The blood plasma vitamin A decreased from 31.0 micrograms per cent the first day prepartum to 22.0 the fourth day postpartum.

The carotene content of the colostrum decreased from 290 micrograms per cent the first day to 102 the fourth day postpartum. The vitamin A content of the colostrum decreased from 250 micrograms per

cent the first day to 92 the fourth day postpartum.

The blood plasma calcium varied from a low of 9.6 milligrams per cent the second day postpartum to a high of 11.1 the fourth day postpartum. The blood plasma phosphorus decreased from 5.7 milligrams per cent the third day prepartum to 3.2 the fourth day postpartum.

The calcium content of the colostrum decreased from 0.300 per cent the first day to 0.150 the third day and then increased to 0.160 per cent the fourth day postpartum. The phosphorus content of the colostrum decreased from 0.290 per cent the first day to 0.165 the second day and then further decreased to 0.119 per cent the third day and then increased to 0.140 on the fourth day postpartum.

There was some congestion in the udder in all quarters at the time of parturition. By the fourth day postpartum the udder still had considerable congestion in it, especially in the left rear quarter. The milk which was secreted on the fourth day postpartum appeared to be normal. The bacteria count was low, ranging from 3000 to 4500 per ml. during this time.

Cow No. 98 (Appendix, Table XXVI), a three year old Holstein in her third lactation, was a check cow. She produced up to 51.5 pounds of colostrum on the fourth day postpartum.

The blood plasma carotene decreased from 700 micrograms per cent the first day prepartum to 515 the fourth day postpartum. The blood plasma vitamin A was maintained at 28.0 micrograms per cent until the fourth day postpartum at which time it decreased to 26.0.

The carotene content of the colostrum decreased from 237 micrograms per cent the second day to 99 the fourth day postpartum. The vitamin A content of the colostrum decreased from 58 the second day to 40 micrograms per cent the fourth day postpartum.

The blood plasma calcium decreased from 11.4 milligrams per cent the third day prepartum to 7.9 the second day postpartum, and then it increased to 10.2 the fourth day postpartum. The blood plasma phosphorus varied from a high of 5.3 milligrams per cent the first day prepartum to a low of 3.7 the second day postpartum.

The calcium content of the colostrum decreased from 0.240 the first day to 0.140 per cent the third day postpartum. The phosphorus content of the colostrum decreased from 0.200 per cent the first day to 0.130 the fourth day postpartum.

The udder was very congested at the time of parturition. By the fourth day postpartum the congestion was somewhat relieved, but the left rear and the left front quarters were still very hard and inflamed. The bacteria count was less than 3000 per ml. all through the experimental period.

Cow No. 140 (Appendix, Table XXVII), a two year old Holstein in her first lactation, was a check cow, and produced up to 32.2 pounds of colostrum on the fourth day postpartum.

The blood plasma carotene decreased from 435 micrograms per cent the fifth day prepartum to 330 the fourth day postpartum. The blood plasma vitamin A decreased from 28.0 micrograms per cent the third day prepartum to 18.0 the fourth day postpartum.

The carotene content of the colostrum decreased from 238 micrograms per cent the first day to 136 the fourth day postpartum. The vitamin A content of the colostrum decreased from 238 micrograms per cent the first day to 122 the fourth day postpartum.

The blood plasma calcium decreased from 11.3 milligrams per cent the third day prepartum to 9.1 the fourth day postpartum. The blood plasma phosphorus decreased from a high of 5.6 milligrams per cent the third day prepartum to 1.5 the fourth day postpartum.

The calcium content of the colostrum decreased from 0.320 per cent the first day to 0.180 the fourth day postpartum. The phosphorus content of the colostrum decreased from 0.260 the first day to 0.141 the third day, and then increased to 0.150 per cent the fourth day postpartum.

There was considerable congestion in the udder as parturition time approached. By the fourth day postpartum the congestion had not been relieved. The bacteria count was less than 3000 per ml. all through the experimental period.

Cow No. 11 (Appendix, Table XXVIII), a six year old Jersey in her sixth lactation was premilked fifteen days. She produced up to 23.9 pounds of colostrum on the fourth day postpartum.

The blood plasma carotene varied from a high of 2810 micrograms per cent on the fifth day prepartum to a low of 1080 on the fourth day postpartum. The blood plasma vitamin A decreased from 19.3 micrograms per cent on the seventh day prepartum to 8.1 on the second day postpartum and then increased to 10.3 on the fourth day postpartum.

The carotene content of the colostrum varied from a high of 252 micrograms per cent on the first day postpartum to a low of 106 on the fourth day postpartum. The vitamin A content of the colostrum varied from a low of 55 micrograms per cent on the second day to a high of 252 on the first day prepartum.

The blood plasma calcium varied from a high of 11.2 milligrams per cent on the first day prepartum to a low of 6.2 on the second day postpartum. The blood plasma phosphorus varied from a low of 1.7 milligrams per cent on the second day postpartum to a high of 9.5 on the fourth day postpartum.

The calcium content of the colostrum varied from a low of 0.138 per cent on the third day postpartum to a high of 0.181 on the first day prepartum. The phosphorus content of the colostrum began with 0.123 on the tenth day prepartum and increased to 0.155 per cent on the fifth day prepartum and then showed a downward trend to 0.107 on the third day and fourth day postpartum.

The amount of secretion from this cow increased very slowly during the experimental period. Her udder was also very soft, and pliable. She came down with milk fever the day before calving and again on the day of calving. She was treated for milk fever with calcium gluconate both times. She began her recovery the second day postpartum and by the fourth day postpartum she apparently was normal and was increasing rapidly in the amount of milk secreted. Very few organisms were found in the colostrum at any time during the experimental period.

Cow No. 36 (Appendix, Table XXIX), a three year old Jersey cow in

her second lactation, was premilked four days and produced from 1.4 pounds of milk the fourth day prepartum up to 35.0 pounds the fourth day postpartum. There was a steady increase in her production during the experimental period.

The blood plasma carotene showed a downward trend from a value of 2150 micrograms per cent the first day prepartum to 1760 the fourth day postpartum. The blood plasma vitamin A varied from a low of 21.5 micrograms per cent the second day postpartum to a high of 55.8 the fourth day postpartum.

The carotene and vitamin A content in the colostrum and blood plasma calcium and phosphorus were not determined.

The calcium content of the colostrum varied from a low of 0.144 per cent the fourth day prepartum to a high of 0.222 the fourth day postpartum. The phosphorus content of the colostrum showed the same trend beginning with a low of 0.130 the fourth day prepartum reaching a high of 0.225 per cent the first day postpartum, then decreased to 0.150 the fourth day postpartum.

The udder was very soft and pliable throughout the experimental period. The left front quarter was underdeveloped and produced less milk than the other quarters. On the fourth day postpartum this quarter still gave the least amount of secretion. Very few organisms were found during the experimental period.

Cow No. 32 (Appendix, Table XXX), a four year old Jersey in her second lactation, was premilked sixteen days, and produced from 0.1 pound the tenth day prepartum to 37.2 pounds the fourth day postpartum.

The blood plasma carotene decreased from 590 micrograms per cent the seventh day prepartum to 465 the fourth day postpartum. The blood plasma vitamin A varied from a high of 28.5 micrograms per cent the third day prepartum to 18.0 the second day postpartum and then increased to 26.5 the fourth day postpartum.

The carotene content of the colostrum increased to a high of 386 micrograms per cent the first day postpartum and then decreased to 253 the fourth day postpartum. The vitamin A content of the colostrum decreased from 310 micrograms per cent the first day prepartum to 72 the fourth day postpartum.

The blood plasma calcium decreased from a high of 17.2 milligrams per cent the seventh day prepartum to a low of 6.2 the second day postpartum and then increased to 11.6 the fourth day postpartum. The blood plasma phosphorus varied from a high of 4.6 milligrams per cent the first day prepartum to a low of 2.2 the second day postpartum.

The calcium content of the colostrum increased up to a high of 0.253 per cent the first day postpartum and then decreased to 0.214 per cent the fourth day postpartum. The phosphorus content of the colostrum increased to a high of 0.160 per cent the first day postpartum and then varied to 0.154 per cent on the fourth day postpartum.

This cow increased her milk flow very slowly and did not secrete an appreciable quantity until the fifth day prepartum. The udder developed some congestion after parturition, but the congestion had

nearly disappeared by the fourth day postpartum.

Cow No. 53 (Appendix, Table XXXI), a four year old Jersey in her third lactation, was premilked seven days. She produced up to 32.4 pounds of colostrum on the third day postpartum.

The blood plasma carotene decreased from 350 micrograms per cent the seventh day prepartum to 220 the second day postpartum and then increased to 250 the fourth day. The blood plasma vitamin A varied from a high of 30.0 micrograms per cent the seventh day prepartum to a low of 20.0 the second day postpartum.

The carotene content of the colostrum varied from a high of 204 the seventh day prepartum to a low of 81 micrograms per cent the fourth day postpartum. The vitamin A content of the colostrum varied from a high of 113 micrograms per cent the seventh day prepartum to a low of 36 the fourth day postpartum.

The blood plasma calcium varied from a low of 9.6 milligrams per cent the ninth day to a high of 14.1 on the third day prepartum with no definite trend. The blood plasma phosphorus decreased from a high of 6.0 milligrams per cent the fifth day prepartum to a low of 3.4 the fourth day postpartum.

The calcium content of the colostrum varied from a high of 0.165 per cent the fifth day to a low of 0.110 the third day prepartum.

The phosphorus content of the colostrum varied from a low of 0.129 per cent the sixth day to a high of 0.152 the third day prepartum with no definite trend.

Some blood appeared in the colostrum during the experimental period

The udder became somewhat congested after parturition, but by the fourth day it was completely free from congestion.

Cow No. 11 (Appendix, Table XXXII), a nine year old Jersey in her eighth lactation, was premilked, thirteen days. She produced up to 27.2 pounds of colostrum the fourth day postpartum.

The blood plasma carotene varied from a high of 310 micrograms per cent the first day prepartum to 200 the second day postpartum. The blood plasma vitamin A decreased from 23.0 micrograms per cent the seventh day to 10.0 the first day prepartum, and increased to 23.0 on the fourth day postpartum.

The carotene content of the colostrum decreased from 188 micrograms per cent the first day to 68 the fourth day postpartum. The vitamin A content of the colostrum decreased from 122 micrograms per cent the first day to 50 the fourth day postpartum.

The blood plasma calcium showed a downward trend from 13.1 milligrams per cent the ninth day prepartum to 10.2 the second day postpartum and then increased to 12.8 on the fourth day. The blood plasma phosphorus decreased from 5.2 milligrams per cent the seventh day prepartum to 2.8 the fourth day postpartum.

The calcium content of the colostrum decreased from a high of 0.183 the first day to 0.146 per cent the third day and then again increased to 0.182 the fourth day postpartum. The phosphorus content of the colostrum decreased from 0.155 per cent the first day to 0.124 the fourth day postpartum.

This cow had milk fever before and after parturition. She was

treated both times with calcium gluconate. Her milk flow increased very slowly, giving very little until after parturition. The udder was very soft and pliable, and seemed to be completely free of congestion at all times.

Gow No. 56 (Appendix, Table XXXIII), a four year old Jersey in her third lactation, was premilked six days. She produced up to 42.9 pounds of colostrum the fourth day postpartum. The blood plasma vitamin A likewise increased to 29.0 micrograms per cent the first day prepartum and then decreased to 18.0 the fourth day postpartum.

The carotene content of the colostrum decreased from 192 micrograms per cent the fourth day prepartum to 62 the fourth day postpartum. The vitamin A content of the colostrum varied from a high of 128 micro-grams per cent the fifth day prepartum to a low of 43 the fourth day postpartum.

The blood plasma calcium showed a decrease from 10.0 milligrams per cent the first day prepartum to 9.0 the fourth day postpartum. The blood plasma phosphorus showed a decrease of 4.5 milligrams per cent the third day prepartum to 3.2 the second day postpartum, and then increased to 3.4 the fourth day postpartum.

The calcium content of the colostrum decreased from 0.242 per cent the fifth day prepartum to 0.186 on the first day prepartum. It then increased to 0.205 per cent the first day postpartum, then again decreased to 0.172 on the fourth day. The phosphorus content of the colostrum showed a downward trend from 0.180 per cent the

third day prepartum to 0.129 the fourth day postpartum.

The udder became somewhat congested after parturition, and this congestion remained through the fourth day postpartum. The bacteria count was very low during this experimental period, ranging from less than 3000 to 8500 per ml.

Cow No. 50 (Appendix, Table XXXIV), a three year old Jersey in her third lactation, was premilked six days and produced up to 31.3 pounds of colostrum on the third day postpartum.

The blood plasma carotene increased to 350 micrograms per cent the first day prepartum, and then decreased to 250 the fourth day postpartum. The blood plasma vitamin A decreased from 35.0 micrograms per cent the fifth day prepartum to 13.0 the fourth day postpartum.

The carotene content of the colostrum varied from a high of 162 micrograms per cent on the first day to a low of 72 the fourth day postpartum. The vitamin A content of the colostrum varied from a high of 112 micrograms per cent the third day to a low of 66 the fourth day postpartum.

The blood plasma calcium decreased from 11.7 milligrams per cent the fifth day prepartum to 7.2 on the second day postpartum and then increased to 9.2 on the fourth day postpartum. The blood plasma phosphorus increased to a high of 6.0 milligrams per cent the first and third days prepartum and then dropped to a low of 4.4 the second day postpartum, and then again increased to 4.7 on the fourth day postpartum.

The calcium content of the colostrum decreased from 0.240 per cent the first day prepartum to 0.164 the fourth day postpartum. The phosphorus content of the colostrum decreased from 0.244 per cent the first day prepartum to 0.142 per cent the fourth day postpartum.

This cow increased her milk flow very slowly, producing practically none until the day before freshening. At first only a black, bloody secretion appeared. She had milk fever the second day postpartum and was treated with calcium gluconate. The fourth day postpartum there was slight congestion in the front quarters and she was still producing colostrum containing blood.

Cow No. 29 (Appendix, Table XXXV), a five year old Jersey in her fourth lactation, was premilked eight days, and produced up to 39.2 pounds of colostrum on the fourth day postpartum.

The blood plasma carotene varied from a low of 280 micrograms per cent the fifth day prepartum up to a high of 360 the fourth day postpartum. The blood plasma vitamin A decreased from 27.1 micrograms per cent the fifth day prepartum to 18.4 the second day postpartum, and then increased to 20.9 on the fourth day postpartum.

The carotene content of the colostrum varied from a high of 344 micrograms per cent the first day prepartum to a low of 81 the fourth day postpartum. The vitamin A content of the colostrum decreased from 174 micrograms per cent the seventh day prepartum to 62 the third day and then again increased to 112 the first day prepartum, and then again decreased to 12 on the fourth day postpartum.

The blood plasma calcium varied from a high of 9.6 milligrams per cent on the fifth day to a low of 7.8 on the first day prepartum. The blood plasma phosphorus decreased from 4.5 milligrams per cent the third day prepartum to 2.2 the fourth day postpartum.

The calcium content of the colostrum varied from a high of 0.169 per cent the seventh day prepartum to a low of 0.146 the second day postpartum. The Phosphorus content of the colostrum varied from a low of 0.122 per cent the seventh day to a high of 0.148 the fourth day prepartum with no set trend.

The udder contained some swelling as it began to function, but by the fourth day postpartum it was completely free of congestion, being very soft and pliable, and secreted normal milk. The bacteria count was very low throughout the experimental period, ranging from less than 3000 to 7000 per ml.

Gow No. 102 (Appendix, Table XXXVI), a two year old Jersey in her first lactation, was premlked seven days and she produced up to 28.2 pounds of colostrum on the fourth day postpartum.

The blood plasma carotene varied from 910 micrograms per cent the seventh day to a low of 530 on the fifth day prepartum with no definite trend. The blood plasma vitamin A decreased from 28.0 micrograms per cent the seventh day prepartum to 21.0 the second day postpartum, and then increased to 25.0 on the fourth day postpartum.

The carotene content of the colostrum decreased from 512 micrograms per cent the sixth day prepartum to 70 the third day postpartum. The vitamin A content of the colostrum decreased from 110 micrograms

per cent the sixth day prepartum to 12 on the fourth day postpartum.

The blood plasma calcium varied from a high of 11.2 milligrams per cent the first day prepartum to a low of 9.7 the second day postpartum. The blood plasma phosphorus showed a downward trend from 6.0 milligrams per cent the seventh day prepartum to 3.8 on the fourth day postpartum.

The calcium content of the colostrum varied from a high of 0.213 per cent on the sixth day to a low of 0.149 on the fourth day prepartum, with no set trend. The phosphorus content of the colostrum varied from a high of 0.178 per cent the sixth day prepartum to a low of 0.140 on the fourth day postpartum.

The udder became quite congested as parturition approached, but by the fourth day postpartum the congestion had been relieved considerably.

Cow No. 131 (Appendix, Table XXXVII), a two year old Jersey in her first lactation, was premilked sixteen days, and produced up to 29.0 pounds on the fourth day postpartum.

The blood plasma carotene showed a downward trend from a high of 590 micrograms per cent the ninth day prepartum to a low of 320 on the fourth day postpartum. The blood plasma vitamin A decreased from 36.0 micrograms per cent the ninth day prepartum to 10.0 the third day postpartum and then increased to 12.0 on the fourth day postpartum.

The carotene content of the colostrum decreased from a high of

228 micrograms per cent the first day prepartum to a low of 78 on the fourth day postpartum. The vitamin A content of the colostrum increased to 174 micrograms per cent the first day prepartum and then decreased to a low of 38 on the fourth day postpartum.

The blood plasma calcium decreased from 10.3 milligrams per cent the ninth day prepartum to 8.2 the second day postpartum and then again increased to 8.4 on the fourth day postpartum. The blood plasma phosphorus showed a downward trend from 4.6 milligrams per cent the ninth day prepartum to 1.8 on the fourth day postpartum.

The calcium content of the colostrum varied from a high of 0.170 per cent on the fourth day prepartum and the first day postpartum to a low of 0.140 on the second day prepartum and the third and fourth days postpartum. The phosphorus content on the colostrum varied from a high of 0.160 per cent on the third day prepartum to a low of 0.120 on the third day postpartum, with no set trend.

This cow increased in milk flow very slowly. She produced a bloody secretion at the beginning of the experimental period. After parturition the udder became very congested, but by the fourth day postpartum the congestion was gone from all quarters except the left rear. The bacteria count ranged from 31,500 to less than 3000 per ml. during the experimental period.

Cow No. 90 (Appendix, Table XIXVIII), a three year old Jersey was premilked six days, and she produced up to 26.6 pounds of colostrum by the fourth day postpartum.

The blood plasma carotene showed a downward trend from 1050 micro-

grams per cent on the third day prepartum to a low of 730 on the fourth day postpartum. The blood plasma vitamin A decreased from 33.0 micrograms per cent on the fifth day prepartum to 18.0 on the fourth day postpartum.

The carotene content of the colostrum increased to a high of 368 micrograms per cent on the second day postpartum and then decreased to 213 on the fourth day. The vitamin A content of the colostrum varied from a low of 37 micrograms per cent the first day prepartum to a high of 103 the second day postpartum.

The blood plasma calcium showed a downward trend from 9.9 milligrams per cent the fifth day prepartum to 8.6 on the fourth day postpartum. The blood plasma phosphorus showed a decrease from 3.9 milligrams per cent the third day prepartum to a low of 1.8 on the fourth day postpartum.

The calcium content of the colostrum increased up to 0.190 per cent on the first day postpartum and then decreased to 0.140 on the fourth day postpartum. The phosphorus content of the colostrum increased to 0.150 per cent on the first day prepartum, then decreased to 0.120 on the second day postpartum and then again increased to 0.140 on the fourth day postpartum.

The udder became quite congested after parturition and a bloody secretion was produced. She increased in milk flow very slowly. On the fourth day postpartum there was still a slight congestion in all four quarters. The bacteria count ranged from a high of 131,500 to a low of 7000 per ml.

Cow No. 23 (Appendix, Table XXXIX), a seven year old Jersey in her sixth lactation, was premilked sixteen days, and produced up to 35.2 pounds of colostrum on the fourth day postpartum.

The blood plasma carotene decreased from 530 micrograms per cent the ninth day prepartum to 425 on the second day postpartum. The blood plasma vitamin A decreased from 31.0 micrograms per cent on the ninth day prepartum to 23.0 on the fourth day postpartum.

The carotene content of the colostrum decreased from 319 micrograms per cent the first day prepartum to 76 on the fourth day postpartum. The vitamin A content of the colostrum decreased from 100 micrograms per cent on the first day prepartum to 47 on the fourth day postpartum.

The blood plasma calcium showed a downward trend from 10.0 milligrams per cent on the seventh day prepartum to 5.0 on the second day postpartum, and then increased to 6.4 on the fourth day postpartum. The blood plasma phosphorus decreased from 3.5 milligrams per cent the first day prepartum to a low of 1.1 on the second day postpartum. It then increased to 2.6 milligrams per cent on the fourth day postpartum.

The calcium content of the colostrum decreased from 0.430 per cent the first day prepartum to 0.260 the fourth day postpartum. The phosphorus content of the colostrum varied from a high of 0.225 per cent the first day to a low of 0.090 the third day postpartum.

This cow increased in milk flow very slowly. The udder had some swelling after parturition, but no hardness. The bacteria

count ranged from a high of 1,525,000 to a low of 7,500 per ml.

Cow No. 94 (Appendix, Table XI), a three year old Jersey in her second lactation, was premilked sixteen days. She produced up to 28.0 pounds of colostrum on the fourth day postpartum.

The blood plasma carotene decreased from 750 micrograms per cent the seventh day prepartum to 515 the fourth day postpartum. The blood plasma vitamin A varied from a high of 33.0 micrograms per cent the seventh day prepartum to 26.0 the second day postpartum.

The carotene content of the colostrum decreased from 186 micro-grams per cent the third day prepartum to 77 the fourth day postpartum. The vitamin A content of the colostrum decreased from 114 micrograms per cent the third day prepartum to 57 the second day postpartum, and then increased to 71 on the fourth day postpartum.

The blood plasma calcium showed a downward trend from 10.8 milligrams per cent the ninth day prepartum to 8.4 the second day postpartum. The blood plasma phosphorus decreased from 4.4 milligrams per cent the ninth day prepartum to 2.5 the second day postpartum and then increased to 3.3 on the fourth day postpartum.

The calcium content of the colostrum decreased from 0.480 per cent the second day prepartum to 0.235 on the fourth day postpartum. The phosphorus content of the colostrum decreased from 0.250 per cent the third day prepartum to 0.175 on the fourth day postpartum.

This cow increased in her milk flow very slowly. There was no

congestion in the udder at any time.

Cow No. 11 (Appendix, Table XII), a seven year old Jersey, was a check cow. She produced 1.0 pound of milk the first day and 24.2 pounds the fourth day postpartum.

The blood plasma carotene varied from a high of 250 micrograms per cent the fifth day prepartum to a low of 160 the fourth day postpartum. The blood plasma vitamin A varied from a high of 20.0 micrograms per cent the ninth day prepartum to a low of 8.0 on the fourth day postpartum.

The carotene content of the colostrum had a downward trend from 424 micrograms per cent the first day to 53 on the fourth day postpartum. The vitamin A content of the colostrum showed a similar downward trend from 282 micrograms per cent the first day to 45 on the fourth day postpartum.

The plasma calcium varied from a high of 16.5 milligrams per cent the ninth day prepartum to a low of 4.9 on the fourth day postpartum. The plasma phosphorus varied from a high of 5.1 milligrams per cent the fifth day to a low of 1.9 on the first day prepartum.

The calcium content of the colostrum was 0.203 per cent the first day and 0.166 on the fourth day postpartum. The phosphorus content of the colostrum showed a downward trend from 0.190 per cent the first day to 0.140 on the fourth day postpartum.

This cow had milk fever on the first day prepartum and again on the first day postpartum. She was treated with calcium gluconate each time. The udder was very soft and pliable throughout the

experimental period. Very few organisms were found at any time during this period.

Cow No. 62 (Appendix, Table XIII), a two year old Jersey was a check cow. She produced 5.5 pounds of colostrum the first day and 27.7 pounds the fourth day postpartum.

The blood plasma carotene had a downward trend from 375 micrograms per cent the first day prepartum to 330 on the fourth day postpartum. The blood plasma also showed a downward trend from 19.7 micrograms per cent the second day to 10.0 on the fourth day postpartum.

The carotene content of the colostrum showed a decrease from 238 micrograms per cent the first day to 51 the fourth day postpartum. The vitamin A content of the colostrum decreased from 378 micrograms per cent the first day to a low of 191 on the third day postpartum.

The blood plasma calcium decreased from 10.8 milligrams per cent on the first day prepartum to 8.8 the fourth day postpartum. The blood plasma phosphorus decreased from 4.9 milligrams per cent on the first day prepartum to 3.2 on the fourth day postpartum.

The calcium content of the colostrum decreased from 0.196 per cent the first day to 0.143 on the fourth day postpartum. The phosphorus content of the colostrum decreased from 0.175 per cent on the first day to 0.115 on the fourth day postpartum.

The udder was very congested, with edema very apparent. This condition was only slightly relieved by the fourth day postpartum.

The bacteria count was quite low during this period, ranging from a low of less than 3000 to a high of 5000 per ml.

Cow No. 52 (Appendix, Table XIII), a three year old Jersey, second lactation, was a check cow. She produced up to 26.8 pounds of colostrum the fourth day postpartum.

The blood plasma carotene increased from 300 micrograms per cent the fifth day prepartum to a high of 510 the first day prepartum and then showed a value of 500 on the fourth day postpartum. The blood plasma vitamin A increased to a high of 35.0 micrograms per cent the first day prepartum and then decreased to 22.0 the fourth day postpartum.

The carotens content of the colostrum decreased from 336 micrograms per cent the first day to 89 on the fourth day postpartum. The vitamin A content of the colostrum decreased from 142 micrograms per cent the first day to 23 on the fourth day postpartum.

The blood plasma calcium decreased from 10.4 milligrams per cent the ninth day prepartum to a low of 6.5 the second day postpartum and then increased to 7.2 on the fourth day postpartum. The blood plasma phosphorus varied from a low of 4.1 milligrams per cent the fifth day prepartum to a high of 6.8 the third day prepartum. The fourth day postpartum showed a value of 5.6 milligrams per cent.

The calcium content of the colostrum decreased from 0.241 per cent the first day to 0.151 the third day and increased to 0.185 per cent the fourth day postpartum. The phosphorus content of the colostrum decreased from a high of 0.208 per cent the first day to

a low of 0.128 the second day postpartum. The fourth day postpartum showed a value of 0.137 per cent.

The udder was in very good condition all during the postpartum period. On the fourth day postpartum, the udder had no congestion whatsoever. The bacteria count ranged from a low of less than 3000 to a high of 11,500 per ml.

Gow No. 62 (Appendix, Table XLIV), a three year old Jersey in her second lactation, was a check cow. She produced up to 40.0 pounds of colostrum on the fourth day postpartum.

The blood plasma carotene varied from a low of 260 micrograms per cent the second day to a high of 280 on the fourth day postpartum. The blood plasma vitamin A decreased from 12.0 micrograms per cent the first day prepartum to 5.0 on the fourth day postpartum.

The carotene content of the colostrum decreased from 297 micrograms per cent the second day to 68 on the fourth day postpartum. The vitamin A content of the colostrum also decreased from 169 micrograms per cent the second day to 57 on the fourth day postpartum.

The blood plasma calcium increased from 7.3 milligrams per cent the first day prepartum to 8.5 on the fourth day postpartum. The blood plasma phosphorus decreased from 3.6 milligrams per cent the first day prepartum to 1.8 on the second day postpartum, then increased to 2.8 on the fourth day postpartum.

The calcium content of the colostrum decreased from 0.205 per cent the first day to 0.185 on the fourth day postpartum. The phosphorus content of the colostrum decreased from 0.190 per cent

the first day to 0.115 per cent the third day and then increased to 0.135 per cent the fourth day of this postpartum period.

There was some congestion of the udder after parturition, especially in the front quarters. By the fourth day postpartum, the udder was free of congestion. The bacteria count ranged from less than 3000 to 5000 per ml. during this time.

Cow No. 38 (Appendix, Table XLV), a five year old Jersey, in her fourth lactation, was a check cow. She produced up to 19.0 pounds of milk the fourth day postpartum.

The blood plasma carotene varied from a high of 550 micrograms per cent the fifth day prepartum to a low of 330 on the fourth day postpartum. The blood plasma vitamin A decreased from 24.0 micrograms per cent the fifth day prepartum to a low of 10.0 on the fourth day postpartum.

The carotene content of the colostrum increased from 166 micrograms per cent the second day to 204 the fourth day postpartum. The vitamin A content of the colostrum varied from a low of 137 micrograms per cent the second day to a high of 154 the third day postpartum with no definite trend.

The blood plasma calcium varied from a high of 11.3 milligrams per cent the fifth day prepartum to a low of 4.6 on the second day postpartum. The blood plasma phosphorus varied from a high of 5.2 milligrams per cent the fifth day prepartum to a low of 1.4 on the second day postpartum.

The calcium content of the colostrum decreased from 0.249 per

cent the first day to 0.178 the fourth day postpartum. The phosphorus content of the colostrum decreased from 0.221 per cent the first day to 0.163 the fourth day of this postpartum period.

This cow had milk fever the second and third days postpartum, and was treated with calcium gluconate each time. The udder never had any congestion in it whatsoever. The bacteria count of the colostrum ranged from a high of more than 300,000 to less than 3000 per ml.

Cow No. 55 (Appendix, Table XVII), a four year old Jersey in her third lactation, was a check cow. She produced up to 30.2 pounds of colostrum on the fourth day postpartum.

The blood plasma carotene decreased from 1110 micrograms per cent on the seventh day prepartum to 630 on the fourth day postpartum. The blood plasma vitamin A varied from a high of 31.0 micrograms per cent the ninth day prepartum to a low of 14.0 the second day postpartum, and then increased to 16.0 on the fourth day postpartum.

The carotene content of the colostrum increased from 80 micrograms per cent the first day to 109 the third day and then decreased to 48 on the fourth day postpartum.

The blood plasma calcium varied from a high of 10.3 milligrams per cent on the ninth day prepartum to a low of 5.8 the second day postpartum, increasing to 9.1 on the fourth day postpartum. The blood plasma phosphorus decreased from a high of 3.6 milligrams per cent on the seventh day prepartum to a low of 0.6 on the second day

postpartum.

The calcium content of the colostrum decreased from 0.191 per cent the first day to 0.120 the third day, and then increased to 0.130 on the fourth day postpartum. The phosphorus content of the colostrum decreased from 0.150 per cent the second day to 0.120 on the fourth day postpartum.

This cow had no congestion at any time and produced milk that appeared normal after parturition. The bacteria count of the colostrum ranged from a high of 445,000 to a low of less than 3000 ml.

Cow No. 93 (Appendix, Table XLVII), a three year old Jersey in her second lactation, was a check cow. She produced up to 32.8 pounds of colostrum on the fourth day postpartum. The blood plasma carotene varied from a high of 910 micrograms per cent the first, third, and fifth days prepartum to a low of 830 on the second day postpartum. The blood plasma vitamin A decreased from 35.0 micrograms per cent the third day prepartum to 26.0 on the fourth day postpartum.

The carotene content of the colostrum decreased from 169 micrograms per cent the first day to 82 on the fourth day postpartum. The vitamin A content of the colostrum decreased from 149 micrograms per cent the first day to 80 on the fourth day postpartum.

The blood plasma calcium varied from a high of 10.0 milligrams per cent the third day prepartum to a low of 8.0 the second day postpartum. The blood plasma phosphorus reached a high of 4.8 milligrams per cent the first and third days prepartum, then decreased to

2.3 on the fourth day postpartum.

The calcium content of the colostrum decreased from 0.260 per cent the first day to 0.185 the third day, then increased to 0.190 the fourth day in this postpartum period. The phosphorus content of the colostrum decreased from 0.260 per cent the first day to 0.195 the third day and then increased to 0.200 per cent the fourth day postpartum.

There was no congestion in the udder at any time. The bacteria count of the colostrum was quite low during this period, ranging from less than 3000 to 5500 per ml.

### DISCUSSION OF RESULTS

A summary of the results is given in Tables I to IV inclusive. The average amount of colostrum produced by the prepartum milked Holstein cows in Group I increased from 1.5 pounds on the tenth day prepartum to 24.8 pounds on the first day prepartum, and then increased to 52.8 pounds the fourth day postpartum. The average amount of colostrum produced by Group II, the Holstein check group, increased from 18.8 pounds the day of freshening to 39.6 pounds the fourth day postpartum. The average amount of colostrum produced by Group III, the prepartum milked Jerseys, increased from 0.3 pounds the tenth day prepartum to 8.9 pounds on the first day prepartum and up to 31.6 pounds the fourth day postpartum. The average amount of colostrum produced by Group IV, the Jersey check group, increased from 12.8 pounds the day of parturition to 28.6 pounds on the fourth day postpartum.

Comparison of the colostrum produced by the various groups is shown in Figure 1, which shows that the prepartum milked Holstein cows increased in amount of secretion much more readily than did the prepartum milked Jerseys. There was a steady increase in the secretion of both breeds, however, with the greatest amount of increase beginning about the third day before freshening. The prepartum milked groups of both breeds gave more milk on the freshening day than did the check groups, and at four days postpartum the quantity still remained above that given by the check groups. The differences in the amount of colostrum produced were analyzed statistically by analysis of variance using the correction factor for disproportion. The analysis of variance is shown in Tables V

and VI. It was found that for the Holstein breed the differences were highly significant at the one per cent level, while for the Jersey breed the differences were insignificant at the five per cent level. This would indicate that the Holstein cows when prepartum milked would reach a higher peak in the lactation curve. This may result in a higher total production for the lactation following prepartum milking. The increased production from prepartum milked cows substantiates the results obtained by Dawdy and Knodt (23) and Keyes (62) at the Pennsylvania Agricultural Experiment Station.

The blood plasma carotene showed some variations at the beginning in all groups and then showed a downward trend that persisted through the second day postpartum as is shown in Figure 2. Group II, the Holstein check group, decreased the fastest of any group and decreased to a lower point, but showed an increase beginning the second day postpartum. The prepartum milked groups had a higher level of blood carotene. The carotene content of the colostrum also varied somewhat in the prepartum milked groups at the beginning and then showed a downward trend through the fourth day postpartum. The check groups showed a steady successive decrease during the four postpartum days.

The blood plasma vitamin A showed only a slight downward trend and very little variation in all four groups as is shown in Figure 3. In the two prepartum milked groups the vitamin A content of the colostrum varied considerably until the first day prepartum, at which time it began decreasing. This downward trend persisted through the fourth day postpartum. The vitamin A content of the colostrum in the two check

groups started at a higher level the first day postpartum than found at any time in the prepartum milked groups. It then decreased very rapidly to the fourth day postpartum.

The blood plasma calcium of all groups (Figure 4) showed only a slight downward trend to the first day prepartum, at which time there was a sharper decrease to the second day postpartum. It then increased slightly to the fourth day postpartum. The calcium content of the colostrum of Group I increased up to the fourth day prepartum and then decreased to the fourth day postpartum. The calcium content in the colostrum of Group III increased to the first day prepartum and then decreased to the third day postpartum. Group III began decreasing at a later date than did Group I. This may have been due to Jersey cows coming to their milk flow more slowly than did the Holsteins.

The blood plasma phosphorus (Figure 5) varied somewhat and all groups showed a decrease beginning the first day prepartum, reaching a low point the second day postpartum. The blood plasma phosphorus levels were below that found by several investigators (45, 51, 59, 91) for normally fed mature dairy cows. The drop in the blood plasma phosphorus substantiates the work of Van Lendingham and Henderson (112) who discovered that there was a drop in the inorganic phosphorus of the blood at or immediately following parturition. This is more pronounced in animals on a low phosphorus ration.

Table VII shows that prepartum milking along with massage tended to relieve or prevent congestion in the udders of the Holsteins used in this experiment. Only 15.8 per cent of the prepartum milked Holstein

cows in Group I had badly congested udders on the fourth day postpartum compared with 62.5 per cent of the check Holstein cows in Group II which had badly congested udders. However, the results were opposite with the Jersey breed. Only 46.2 per cent of the prepartum milked Jersey cows in Group III had apparently normal udders on the fourth day postpartum compared with 85.7 per cent in Group IV, the check Jersey group which had normal udders. This seems to substantiate in part the work done by Eaton (31). He stated that prepartum milking does not significantly reduce udder congestion.

There were no milk fever cases occurring in any of the Holstein cows. Seven milk fever cases occurred in the Jersey cows used in the experiment. A total of 23.2 per cent of the prepartum milked Jersey cows had milk fever compared with 42.9 per cent of the check Jersey cows in Group IV. In all cases of milk fever that occurred in the prepartum milked Group III Jerseys, the cows did not come to their expected flow of milk before parturition.

The differences in the rate of gain (Tables VIII and IX) of calves from prepartum and non-prepartum milked dams, were insignificant at the five per cent level.

TABLE V. The analysis of variance for the quantity of colostrum produced by the two Holstein groups.

Source	D.F.	Sum of squares	Mean square	F, Value	F <sub>05</sub>	F <sub>01</sub>
Groups	1	5001	5001	19.5**	3.94	6.90
Days	3	6950	2316			
Interaction	3	117	39			
Individuals	100	25644	256			

TABLE VI. The analysis of variance for the quantity of colostrum produced by the two Jersey groups.

Source	D.F.	Sum of squares	Mean square	F, Value	F <sub>05</sub>	F <sub>01</sub>
Groups	1	2.5	2.5	1	3.98	7.01
Days	3	3092.0	1030.0			
Interaction	3	91.7	30.5			
Individuals	72	6873.6	95.4			

TABLE VII. The per cent of cows having congested udders on the fourth day postpartum.

	Congestion	Slight congestion	No congestion
Group I	15.8	47.4	36.8
Group II	62.5	25.0	12.5
Group III	23.07	30.76	46.15
Group IV	14.29	-	85.71

\*\* This shows significance at the one per cent level, or highly significant.

TABLE VIII. The analysis of variance for the rate of gain of calves from the two Holstein groups.

Source	D.F.	Sum of squares	Mean square	F, Value	FO <sub>5</sub>	FO <sub>1</sub>
Groups	1	2.6	2.6	1	4.00	7.08
Weeks	3	366.1	122.0	5.2*		
Interactions	3	36.6	13.3			
Individuals	60	140.3				

TABLE IX. The analysis of variance for the rate of gain of calves from the two Jersey Groups.

Source	D.F.	Sum of squares	Mean square	F, Value	FO <sub>5</sub>	FO <sub>1</sub>
Groups	1	1.1	1.1	1	4.11	7.39
Weeks	3	118.3	39.4	1.35		
Interactions	3	85.0	28.3			
Individuals	36	1066.0				

\*This shows significance at the five per cent level.

















































































































































































































