EFFECT OF PRENATAL ENERGY INTAKE, MONENSIN AND HEMOPHILUS SOMNUS VACCINATION ON SERUM IMMUNOGLOBULIN VALUES OF SUCKLING BEEF CALVES

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TABLE OF CONTENTS

	Page
ACKNOWLEDGEMENTS	iii
LISTS OF TABLES AND FIGURES	iv
INTRODUCTION	1
REVIEW OF LITERATURE	4
Immune response of the bovine fetus	4
Active immunity of the newborn calf	6
Acquired immunity of the newborn calf	7
Colostral immunoglobulins	8
Colostral cells	11
Non specific antimicrobial factors in the colostrum	12
Factors affecting immunoglobulin concentration in the colostrum	14
Mechanism for the establishment of passive immunity	17
Effects of the different immunoglobulin classes and subclasses	23
Factors affecting the acquisition of passive immunity	24
MATERIALS AND METHODS	31
RESULTS	41
DISCUSSION	64
BIBLIOGRAPHY	91
APPENDIX	102
ABSTRACT	123

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LIST OF TABLES AND FIGURES

Page

Figure 1. Grouping of the heifers according to their nutritional program 32

Figure 2. IgG1 values for beef calves at 48 hours of age. Dams had received low or high energy prepartum diets with or without monensin 42

Figure 3. IgM values for beef calves at 48 hours of age. Dams had received low or high energy prepartum diets with or without monensin 42

Figure 4. IgA values for beef calves at 48 hours of age. Dams had received low or high energy prepartum diets with our without monensin.. 43

Figure 5. IgG2 values for beef calves at 48 hours of age. Dams had received low or high energy prepartum diets with or without monensin 44

Figure 6. Total Ig values for beef calves at 48 hours of age. Dams had received low or high energy prepartum diets with or without monensin 45

Table 1. Immunoglobulin values for beef calves at 48 hours of age. Dams had received high or low energy diets with or without monensin. Means and standard deviation are shown 46

Table 2. Relation between the diets and the immunoglobulin values: least square difference test is shown 46

Table 3. Ig Class values for beef calves at 48 hours of age. Dams were assigned randomly to a vaccinated group (H. somnus bacterin) and a non-vaccinated group. Means STD and LSD are shown 47

Table 4. Ig class values for beef calves at 48 hours of age with regard whether they had nursed or were bottle fed. Means, STD and LSD are shown 47

Page

Table 5. Effects of the sex of the calves on serum immunoglobulin classes at 48 hours of age. Means and LSD are shown 48

Table 6. Effect of the delay of standing for the calves on immunoglobulin class values at 48 hours of age. Results of a covariance study are shown 49

Table 7. Effect of the delay of the first nursing on the immunoglobulin class values of beef calves at 48 hours of age. Results of a covariance study are shown 49

Table 8. Effect of the beef calf birth weight on the immunoglobulin on their immunoglobulin class values at 48 hours of age. Results of a covariance study are shown 50

Table 9. Effect of the beef calf birth weight on their immunoglobulin class values at 48 hours of age. Means, STD and LSD are shown 50

Table 10. Effect of the parturition difficulty on the immunoglobulin class values of beef calves at 48 hours of age. Results of a covariance study are shown 51

Table 11. Effect of the beef dam's weight at parturition on the immunoglobulin class values of their offspring serum at 48 hours of age. Results of a covariance study are shown 52

Table 12. Effect of the beef-dam's weight at parturition on the immunoglobulin class values of their offspring serum at 48 hours of age. Means, STD and LSD are shown 52

Table 13. Effect of the dam's body condition score on the immunoglobulin class values of their offspring serum at 48 hours of age. Means, and LSD are shown 53

Table 14. Effect of the breed of the dams on the immunoglobulin class values of their offspring serum at 48 hours of age. Means and LSD are shown 53

Page

Table 15. Effect of the diets on the weights and body condition scores of the dams at parturition. Means and STD are shown 54

Table 16. Effect of the wind chill factor at birth on the immunoglobulin class values of beef calves at 48 hours of age. Results of a covariance study are shown 54

Table 17. Effect of the wind chill factor during the first 48 hours of age. Results of a covariance study are shown 55

Table 18. Effect of the wind chill factor during the week preceding parturition on the immunoglobulin class values of beef calves at 48 hours of age. Results of a covariance study are shown 55

Table 19. Effect of the wind chill factor during the 2nd week preceding parturition on the immunoglobulin class values of beef calves at 48 hours of age. Results of a covariance study are shown 56

Table 20. Effect of the wind chill factor during the 3rd week preceding parturition on the immunoglobulin class values of beef calves at 48 hours of age. Results of a covariance study are shown 56

Table 21. Effect of the total solar radiation factor during the first 48 hours after birth on the immunoglobulin class values of beef calves at 48 hours of age. Results of a covariance study are shown 57

Table 22. Effect of the total solar radiation factor during the first 24 hours after birth on the immunoglobulin class values of beef calves at 48 hours of age. Results of a covariance study are shown 57

Page

Table 23. Effect of the total solar radiation factor during the week preceding the parturition on the immunoglobulin class values of beef calves at 48 hours of age. Results of a covariance study are shown 58

Table 24. Effect of the total solar radiation factor during the 2nd week preceding the parturition on the immunoglobulin class values of beef calves at 48 hours of age. Results of a covariance study are shown 58

Table 25. Effect of the total solar radiation factor during the 3rd week preceding the parturition on the immunoglobulin class values of beef calves at 48 hours of age. Results of a covariance study are shown 59

Table 26. Summary of the different factors having shown a significant effect on the immunoglobulin transfer in the current study. Results of correlation studies are presented 60

Table 27. Ig class values for beef calves at 48 hours of age with regard to periods of sickness. Means and STD are shown 61

Table 28. Comparison between the immunoglobulin class values in 48 hours beef calf serums during the different periods of sickness. Results of a LSD test are shown 61

Table 29. Ig values for beef calves at 48 hours of age. Comparison between the healthy calves and those which died during the 2nd and 3rd observation period. Means and LSD are shown 62

Table 30. Ig class values for beef calves at 48 hours of age. Comparison between the sick calves which died and the sick calves which survived during the 2nd and 3rd observation periods. Means and LSD are shown 63

INTRODUCTION

The resistance of animals to pathogenic invasion depends not only on the number, nature and virulence factors of the pathogenic agents, but also on a number of complex specific and non-specific host-resistance factors.

Non-specific or innate resistance is that resistance shown by certain species or strains of animals to infections to which other species are susceptible. Two general classes of factors have been identified which explain this phenomenon. First, tissues of resistant animals may not provide optimal conditions for the life of the pathogenic agents. Secondly, resistant animals may have more effective non-specific means such as properdin, lysozyme or the complement system as microbial inhibitors, or interferon as an antiviral substance to fight the invaders. Additionally the animal body is protected by specialized types of phagocytic cells (granulocytes and macrophages) which presumably play an important role in non-specific resistance to infection.

The specific or acquired resistance is different in that it is essentially related to an adaptive response of the body defenses to antigenic stimulus. This response consists of the proliferation of precommitted, sensitized cells, the synthesis of specifically acting antibodies and the establishment of immunologic memory. Specific immunity is described as the sum of the activities of two distinct but

interrelated systems: the humoral-mediated immunity and the cellular-mediated immunity. The humoral system is composed of immunoglobulins which have been synthesized by plasma cells. Plasma cells develop as a result of a transformation following antigenic stimulation of B lymphocytes derived from the yolk sac, the fetal liver and the bone marrow. The cellular system consists of thymus-derived, sensitized lymphocytes (T lymphocytes) which have "killer", "helper" or "suppressor" activities. A part of the B and T cell population also have a capacity of memory, allowing faster and higher immune responses to a subsequent exposure to the same antigen.

Because it depends on such a complex and interrelated system, the resistance to pathogens is of an unstable character and can be more or less perturbed by many factors, such as physiological or environmental conditions. Considering these latter factors, the birth of an animal constitutes certainly the most important change in its whole life. The young animal has to pass from an intrauterine existence where it was completely supported and protected by its mother, to an extrauterine life where it has to fend for itself for most of its vital needs. It is well known that neonates of almost all the species are more susceptible to many infections at birth. Among the domestic species, because of physiological and environmental pecularities, the newborn bovine is particularly susceptible.

The present study was undertaken to investigate the effects of the energy levels of the prepartum diets with or without monensin and the effects of the Midwestern U.S. winter environment on the net immunoglobulin transfer to suckled beef calves at 48 hours of age. The effects of the calf and dam weights at calving, difficulty of parturition, delay of nursing and standing and the relation between the 48 hour serum immunoglobulin concentrations at 48 hours of age an subsequent diseases affecting the calves were also studied.

REVIEW OF LITERATURE

IMMUNE RESPONSE OF THE BOVINE FETUS

In contradiction to what was believed for many years, the bovine fetus is capable of very early immune response. According to SCHULTZ (1973), OSBURN (1974), the stem cells of the immunologic system originate in the yolk sac and migrate to the fetal liver at about 10 to 15 days post-conception. At about 40 days of gestation, the stem cells migrate to the thymus to form the T cell system, and at 50 days some of the stem cell migrate to the bone marrow to form the B cell system. Lymph nodes have been found at 60 days and IgM containing cells have been reported to be in the spleen at about the same time. IgG containing cells have not been found before 145 days. The gut associated lymphoid cells in the lamina propria of the lower ileum, have not been observed before 150 days of gestation.

Lymphoid cells predominate in circulating blood until approximately 120 to 130 days at which time granulocytes have been identified.

Serum immunoglobulins have been detected at low concentrations in the fetal circulation. IgM appears at about 130 days and IgG1 at 135 days. IgG2 and IgA have not been found in the fetus by the cited authors. Fetal immune response to antigenic stimulation has been observed and consisted in an increase of IgM and IgG. The response depends on the

nature of the antigen, and the age of the fetus at the time of antigenic stimulation. The earliest responses would be (according to OSBURN), 141 days for A. marginale, 200 days for BVD and at term for Blue Tongue virus or Br. Abortus.

Concerning the cellular immune response, OSBURN (1974) observed a definite response in lymphocytes from the lymph nodes in fetus from gestation day 200 to day 250. After day 250 the lymphocytic response was insignificant, indicating an impaired response probably related to the increase of plasma concentration of corticoteroids at birth, which has been reported to be 2 to 5 times the prepartum fetal or adult values.

BARTA et al (1972), described the presence of bactericidal factors present as early as gestation day 70 against smooth and rough strains of bacteria. This bactericidal activity appeared to increase in range and in activity with fetal maturation and could be related to some components of the complement system but not to immunoglobulins. Hemolytic complement (C1 to C2) has been reported by GEWURZ et al (1968), to be present in bovine feti at approximately the 4th month of gestation while the serum values in neonates were about one fifth the value for adult cattle. OSBURN (1974) did not detect interferon in serum after in utero infection with BVD virus. However, interferon was found in certain fetal tissues infected with BVD.

ACTIVE IMMUNITY OF THE NEWBORN CALF

BRAMBELL (1970), has shown that active immunization by specific antigens is depressed by the passive transfer of specific antibodies in most species. Antigens interracting with circulating antibodies are removed from the circulation presumably by the reticuloendothelial system and are not presented to the appropriate cells for antibody formation. In the newborn calf receiving colostrum, LOGAN et al (1972) found that immunoglobulin synthesis did not begin until approximately 4 weeks postpartum. McEWAN (1970) had found that hypogamaglobulinemic calves are capable of synthesizing immunoglobulins within the first 14 days after birth. In agammaglobulinemic calves, LOGAN and PENHALE (1971) found that the synthesis of IgG and IgM began within a few days of birth.

LOGAN and PEARSON (1978), using immunofluorescent techniques on colostrum-fed calves, found immunoglobulins in the crypt areas of the small intestine which would suggest that at 3 days postpartum calves were capable of synthesizing immunoglobulins even in the presence of maternal immunoglobulins.

In a more recent report, DEVERY et al (1979) have shown that the new born calf, even when fed colostrum, had the capability for endogenous production of IgG1 during the first three weeks of life. The rate of production has been calculated to be approximately of 1 gm/day and would probably be dependent on the antigenic stimuli to which the calf has been sub-

jected.

BARRAT et al (1979) have demonstrated that the presence in calf serum of passively acquired antibodies against soya protein resulted in significantly greater immunologic responses than in the calf deprived of these antibodies. The serum antibody response was very high and more likely related, according to these authors, to a phenomenon of hyperimmunization rather than to a regular response to dietary antigens.

These contradictory findings may be explained by the observations of SCHULTZ (1973) who found that there would be two different effects depending on the immunoglobulins classes. A suppressive effect would be due to the IgG class, whereas colostral antibodies of the IgM class would have an enhancing effect on the calf's immune response. If true, these hypotheses would be similar to that of HENRY (1968) on the immune response of mice to sheep red blood cells.

ACQUIRED IMMUNITY OF THE NEWBORN CALF

SOLOMON (1971) has shown that the transfer of maternal antibodies to the fetus is dependent upon the tissue layers separating the dam's blood from that of the fetus. In man and primates, where there is an hemochorial placenta, maternal blood is in direct contact with trophoblast and IgG but not IgM, IgA or IgE, are transferred to the fetus. In dogs and cats, with an endotheliochorial type of placentation, the chorionic epithelium is in contact with the endothelium of the maternal capillaries and a small amount of immunoglobulins

(5 to 10% of the total adult value) can be transferred (TIZARD 1977) In cattle, with an epitheliochorial type of placenta, chrionic epithelium is in contact with the uterine tissue and immunoglobulins are not passively or actively transferred to the fetus. Thus, most newborn calves have very little immunoglobulin in their serum, and the passive transfer of antibodies occurs through the absorption of the colostrum.

Many authors have demonstrated the importance of this passive immunity transfer in regards with the susceptibility of calves to neonatal infections. PENHALE (1970) showed that newborn calves with IgG serum concentration of less than 0.8 mg/ml and IgM less than 0.2 mg/ml died from septicemia. Those having an IgG and IgM serum concentration of 5 mg/ml and 0.6 mg/ml respectively developed enteric infections, whereas calves with 7.5 mg/ml of IgG and 0.8 mg/ml of IgM did not develop disease. Other authors (HALLIDAY et al 1978, LOMBA 1978), did not find a significant relationship between the serum globulin concentrations and the incidence of diseases such as enteritis or pneumonia. But it seems that there is consensus that passively acquired immunity is an important factor in the prevention of septicemia, since the active immune responses are inadequate to resist the pathogenic agents in the calf's new environment.

Colostral immunoglobulins

The concentration and relative proportion of different

immunoglobulin in the colostrum differ widely between species. In humans, where IgG is transferred in utero, the major colostral immunoglobulin is IgA. In animals the predominent immunoglobulin in colostrum is IgG and it may account for 65 to 90% of the total immunoglobulin content, while IgA and other immunoglobulins tend to be lesser but significant (TIZARD 1977). IgM is present in small quantities in the lacteal secretions of all species. Bovine colostrum normally contains 50 to 150 mg/ml of immunoglobulins, of which IgG comprises about 95%, IgA only 1% and IgM 4% of the total amount. Within the IgG class, IgG1 represent about 80 to 90% (BUTLER, 1974, SASAKI 1976).

Colostral immunoglobulins of all species are derived from several sources (BRAMBELL 1970). They may be transferred from the maternal blood or synthesized in the mammary gland. The relative importance of these sources is variable between species. Many authors (BRANDON 1971, LINZELL 1974, SASAKI 1977) have shown that the blood transfer of IgG immunoglobulins occurs through a highly specific transport system within the secretery cells and not through a kind of leakage or transudation of blood constituents into the colostrum as was previously thought. SASAKI and LARSON (1977) demonstrated that bovine mammary cells contain surface receptor sites for IgG immunoglobulins which correspond in number and binding affinities to the amount of IgG1 and IgG2 in the colostrum and milk. Presumably, the immunoglobulins would be first

bound to surface receptor sites clustered on the side of the cells, then they would be absorbed in vesicles by pinocytosis which would cross the cell and would be discharged at the other side, following a similar pathway as described in other immunoglobulin transport systems such as intestine or placenta. These surface receptors have their highest affinity during the last 15 days of gestation and the maximal transfer of IgG1 occurs 1 to 3 days before calving (SASAKI et al 1976). This selective transfer ends during the first 2 days of lactation but according to SASAKI, the decrease in IgG1 receptors does not happen during the first two months of lactation. DELOUIS (1978) in a review on this subject, related this phenomenon of transfer closure to the increased milk protein synthesis. The epithelium cells would undergo a large development of the endoplasmic reticulum, of the golgi apparatus, of mitochondria and by the appearance of polarized structures which would depress the possibilities of migration of proteins from the serum through the cell.

The production of colostrum together with the selective transport of IgG1 depends on the fast decrease of progesterone concentration and the increase of estrogen concentration at parturition. Then the action of prolactin and perhaps of the adrenal corticosteroids would sharply decrease immunoglobulin transport by the mammary epithelial cells and increase the secretion of milk components.

It has been calculated that from several hundred grams to over 3 kg of immunoglobulin, mainly IgG1, can be transferred from the pregnant cows' blood to the colostrum during the last 2 weeks before parturition. LARSON (1957) and SASAKI (1976) reported that it can take several weeks postpartum before the IgG blood concentration of the dam increases to the prepartum value.

According to TIZARD, most of the IgM and about half of the IgA would derive from the dam's serum and the rest would be produced locally in the udder. This local production of immunoglobulins, is due to plasmocyte secretion. The plasma cytes derive from B lymphocytes which have had initial antigenic stimulation in other places such as Peyer's patches of the intestine according to LARSON et al (1980). The plasmocytes would be located adjacent to the secretory epithelium. Little is known on the mechanisms of this secretion. Following LARSON (1980) it seems that the IgA would be synthesized and then would be transferred to the alveolar cells where the secretory components would be added, forming SIgA which then would be discharged from the vesicles into lacteal secretions.

Colostral cells

Colostrum and milk contain a variety of cellular constituents, some of which may augment acquisition of passive immunity. The variations in cell numbers and types between

and within species are widely variable. However, the principal cells are macrophages, neutrophils, lymphocytes and plasmocytes. Macrophages are the most abundant type and SMITH (1968) and MOUR (1970) have shown that in the lacteal secretion, they maintain their functional integrity as demonstrated by their amoeboid movements, their ability to phagocytose bacteria and fungi, as well as by their interaction with lymphocytes.

More recently, PARMELY (1976) and HEAD (1978) reported the role of leukocytic cells in the acquisition of passive immunity. LOMBARDO et al (1979) reported that total leukocyte counts and neutrophil numbers were higher in colostrum-fed calves than in colostrum-deprived calves.

HEAD (1978) described that B and T lymphocytes of colostrum are capable of eliciting humoral and cellular immune responses. These lymphocytes seem to represent a selected population of immunocompetant cells which can migrate to the mammary gland. While the B lymphocytes can be transformed into plasmocytes and can synthesize immunoglobulins in the udder, they can also pass into the colostrum and after absorption by the newborn calf can pursue their immunoglobulin secretion function in the calf.

Non-specific antimicrobial factors in the colostrum

There is another source of protection than the immunoglobulins, which consists of non-specific inhibitory systems:

lysozyme, lactoferrin, lactoperoxidase and xanthine oxidase. These systems have not received the same attention as the immunologic systems but recent evidence suggests that they have an important role in immunity, not only by augmenting antibody action, but also by offering protection before the immune response becomes effective.

Lysozyme; Bovine milk contains very little lysozyme compared with human milk, about 13 mg/100 ml instead of 30 mg/ml (CHANDRAN 1964). Only a few bacterial species are killed and lysed by it, but it can interact with complement and antibodies and could lead to lysis of Gram negative organisms, according to WARDLAW (1962). Another property mentioned by HILL and PORTER (1974) is that sIgA can bind complement in the presence of lysozyme, making sIgA bactericidal.

Lactoferrin: Bovine milk also contains very little lactoferrin compared with human milk. But REITER (1966) found appreciable amounts (2 to 5 mg/ml). REITER (1966) and ORAM (1966) demonstrated the bacteriostatic activity of lactoferrin, which proceeds by binding the iron (in the intestinal content) necessary to the growth of E. coli. BULLEN et al (1972) have shown that specific antibodies increased the bacteriostatic activity of the lactoferrin, but ORAM and REITER (1968) demonstrated that good inhibition on E. coli can occur in the absence of antibody with purified lactoferrin.

Lactoperoxidase-thiocyanate-hydrogen peroxidase system

REITER (1968) reported that all three components are

required for the system. This system is bacteriostatic at near neutral pH or bacteriocidal at low pH in the milk. The concentration of lactoperoxidase in bovine milk is high (30 mg/ml) and the highest concentration is attained after parturition. It has been proved (REITER, 1978) that lactoperoxidase concentration in milk depends on the feeding regime. During winter feedings, the lactoperoxidase system tends to be low, but it increases on pasture feeding, particularly with natural pastures. REITER (1978) found that the motility of E. coli in vitro is lost after exposure to the lactoperoxidase system, and that the attachment to isolated brush border cells are prevented. By in vivo experiments, the same author has proved that the killing action of the lactoperoxidase system on E. coli was conserved, and that it tended to reduce the number of days the calves scoured and increase the weight gain.

Other non-antibody inhibitors

According to REITER, properdin, conglutinin, B-lysin and ubiquitin can appear in colostrum but their significance is not yet clear.

Factors affecting colostral immunoglobulin concentration

PENHALE et al (1969) found significant differences in colostral immunoglobulin concentration between breeds particularly in the case of IgG. In one experiment, IgG values in samples of Jersey colostrum were always lower than

those from other breeds, suggesting that there was an underlaying influence on IgG concentrations common to all Jersey samples. However, these authors suggested that this difference reflected environmental and husbandry variations, rather than a true genetic difference between breeds. KRUSE (1970) reported a negative correlation between concentration of immunoglobulins and yield of colostrum in pure breeds. The cow of the Danish Red and White breed gave a higher yield colostrum with a lower immunoglobulin concentration than the Danish Black and White breed. On the other hand, LOGAN (1977) did not find any correlation, positive or negative, between colostral Ig concentration and total milk yield.

HALLIDAY (1978) has found a significant difference in colostrum concentration of Ig between breeds. The Blue-Grey breed has consistently higher IgG1 and IgM concentrations than the Hereford breed. He found also that cows that transferred high immunoglobulin concentration to their calves in the first year tended to do so in the second year.

PORTER (1972) reported that there was a rapid fall in the Ig concentration in colostrum following milking. BUSH et al (1980) reported that the percent of Ig in parturition was 6.03%, 4.25% at 12 hours and 2.41% at 24 hours post partum. By the fourth milking, Ig values are virtually nil.

LOGAN (1977) reported a study on the influence of husbandry on immunoglobulin concentration. He found that poor

husbandry had no apparent influence on immunoglobulin concentration, but that it had a profound effect on the colostrum yield at the first milking and thus on the total Ig secreted. The well-fed housed cows in this experiment gave nearly 3 times as much colostrum as the outwintered cows which had received no supplementary feeding.

WARNER et al (1976) reported that Ig yield from the second lactation is almost double the first and that delaying the time of first milking reduces immunoglobulin concentration.

The length of the dry period does not seem to have any effect on the colostral Ig concentration but WARNER (1976) recommended that this period should not be less than 4 weeks.

The seasons of the year per se do not seem to have any effect on the concentration, but there are great variations among cows in immunoglobulin yields (10% produce less than 100 g and 3% produce over 1 kg).

LOGAN (1975) reported that the older cows (over 8 pregnancies) appeared to have a higher percentage of calves with low serum Ig concentration than younger cows. However, he related this finding to the fact that the older cows had a higher incidence of pendulous udders or large teats and often a previous history of clinical mastitis.

Very few studies have been done on the effect of the alimentation of the dam during late pregnancy on the immunoglobulin transfer to the offspring. HALLIDAY (1978) reported that the effects of the dam's diet was very small, being

completely absent in the first year and probably unimportant although appreciable on the lower range of feeding levels used in the second year.

Mechanism for the establishment of passive immunity

It is well known that the small intestine is permeable to many macromolecules including Ig during the early neonatal life. To be effectively internalized by the calf, the immunoglobulins must escape digestion by the proteolytic enzymes normally secreted by the digestive tract, and a special mechanism must allow their uptake and transport from the intestinal lumen to the plasma compartment.

A trypsin inhibitor has been discovered in the colostrum and it seems that this heat-and-acid-resistant protein plays an important role in the protection of the immunoglobulins and the antibacterial factors contained in the colostrum. BROOK (1978) demonstrated that endogenous complement in colostrum was very sensitive to trypsin and chymotrypin that IgG1 were very slowly attacked by the trypsin and that lactoferrin and transferrin were also susceptible to proteoloysis. He reported that there is a close relationship between the dynamics of secretion of colostrum, trypsin inhibitor and immunoglobulins.

Concerning the absorption of the immunoglobulins by the gut, EL NAGEH found that the region of optimum uptake was in the jejunum. JAMES (1979) reported that uptake would occur

at a greater rate in the middle region of the small intestine. However he suggested that with increased exposure to immunoglobulins, the lower portions may have greater capacity for retaining proteins. According to JAMES, it seems that calves with a shorter intestine would uptake more Ig per units of intestinal tissue than would calves with a longer intestine. LOGAN and PEARSON (1977) using immunoflorescent techniques did not find regional differences in the immunoglobulin absorption. The villous epithelial cells throughout the whole small intestine were capable of absorbing immunoglobulins.

The uptake of colostral immunoglobulins by the epithelial intestinal cells has been described by DEUTSCH et al (1957) as being a two-stage process involving pinocytosis by the epithelial membrane of the enterocytes and transport of the entrapped macromolecules into vacuoles into the intercellular spaces at the lateral or basal membrane. FEY (1971) reported that it takes about 10 minutes for the gammaglobulins to appear in the villi after pinocytosis and that they enter the lymphatic capillaries in 1 to 2 hours. BUSH (1971) and FERRY (1973) showed that the Ig began to appear in the calf's serum 3 to 5 hours after the colostrum has been fed. In a time sequence study, LOGAN in 1978, reported that 5 hours are required to reach the half-maximum concentration of blood immunoglobulins, the maximal concentration being said to be reached on 15 to 48 hours depending on the class of immunoglobulins. The problem of relative efficiencies of

of absorption within the different classes of Ig seems to be controversial. Absorption of Ig has been considered as a non-selective process in lambs (SAWYER et al 1977) and in the calf by KLAUS et al (1969) but as a selective process by PENHALE et al (1973) and by STOTT and MENEFEE (1978). PENHALE (1973) showed that there were individual variations in the proportion of absorption for each class and that IgG was absorbed more rapidly than IgA, which was more rapidly transferred than IgM. He suggested that the rate of absorption was related to the size of the macromolecules. IgM having the greater molecule size (1,000,000 daltons) compared with IgG (150,000 daltons) and IgA (170,000 daltons) would be absorbed less efficiently. Conversely in a more recent work, CABELLO and LEVIEUX (1980) found a shorter time for IgM to reach its maximum concentration (30.6 $\pm$ 1.1 hours) than for IgG1 (33.4 $\pm$ 1.1 hours). These authors proposed that the factors which influence the process would be essentially the rate of equilibration between the intravascular and extravascular body compartments.

STOTT et al (1980) reported that the highest rates of absorption would occur during the first 4 hours after feeding and the comparative rates of absorption among the IgA and IgG immunoglobulins classes appeared to be in proportion to the amount of each immunoglobulin in the colostrum, which does not seem to be the case for IgM class. STOTT and MENEFEE (1978) found that the efficiency of absorption of IgM increased

with decreasing amounts of IgM fed in colostrum. And in another experiment STOTT et al (1979) reported that when the calves were fed with smaller amounts of colostrum, the peak of absorption was reached during the first 4 hours post-feeding whereas with larger amounts of colostrum, the peak of absorption was reached in a period between 4 to 8 hours after feeding.

It has been well demonstrated that the capability for the intestinal epithelial cell to absorb and transport macro-molecules to the calf blood is a transient phenomenon. PENHALE et al (1973) showed that the rate of closure is faster for IgM than for IgG or IgA. According to these authors, closure would start shortly after birth and would be effectively complete at 16 hours for IgM, 22 hours for IgA and 27 hours for IgG. LECCE et al (1973) and LEARY et al (1976) have shown that the closure was related to a process of aging and matura-tion of the epithelial cells which occurs in neonates and which render individual cells incapable of absorbing macro-molecules. However, STOTT (1979) remarked that the progressive aging and maturation process were not the only factors inducing closure, since he found that the high rate of absorption last-ed the 4 first hour period. These findings suggested to him that ingestion of colostrum not only stimulated vigorous absorption in intestinal cells but also may activate the closure process, which would be in concordance with what LECCE found in 1973 in piglets.

Since this phenomenon of closure must play an important role in the immunologic status of the newborn calves, many studies have been done to identify the factors involved in this process.

KRUSE and BUUS (1972), noting relative high plasma concentration of corticosteroid in calves 2 hours after birth, suggested that cortisol could induce changes in the intestinal epithelium leading to a decreased ability to absorb immunoglobulins in a similar manner to what HALLIDAY had described in rats in 1959. But when hyperadrenocorticoidism was induced in calves by exogenous hormones or by naturally-occuring stressors, it was not demonstrated that corticosteroid was responsible for altering intestinal absorption in calves. In fact, STOTT and others (1980) have shown that the contrary more likely occurs. CABELLO and LEVIEUX (1980) showed that, at physiological concentrations in calves, corticosteroids would influence the absorption of immunoglobulins and particularly would increase the absorption of IgM. However, it seems that certain stressful conditions imposed upon the dam during pregnancy would be reflected upon the neonate's capabilities of absorbing immunoglobulins. HUSBAND (1973) reported that corticosteroid treatment of cows in the last 2 months of gestation reduced intestine absorption of Ig by their calves. But MULLER et al (1975), using a more rapid acting glucocorticoid, did not find any effect on gammaglobulin absorption in the neonatal calves. To explain

this difference, STOTT (1980) proposed that the use of more rapid active corticoids together with an injection closer to parturition would not allow enough time for glucocorticoids to act upon the fetal gut.

Testing the effect of thyroid hormones on rat intestine, MALINOWSKA et al (1974) found that these hormones hastened the maturation of the epithelial cells and so hastened the closure of immunoglobulin absorption. NATHANIELSZ (1974), then later CABELLO and LEVIEUX (1978,1979) reported facts that could be explained by a comparable action of thyroid hormones on the calf gut, but it has not yet been convincingly demonstrated. McCOY et al (1970) reported that there was no difference at 31 hours of life in concentration of gamma-globulin in serum of calves fed glucose and those from which feed was withheld for 24 hours before feeding colostrum. JAMES (1976) found a substantial decrease in serum gamma-globulin concentration between calves given an inoculum of duodenal fluid with first feeding of colostrum and control calves. But he was not able to confirm this work (1978). JAMES (1978) reported that the presence and multiplication of bacteria may affect absorption by accelerating cell migration along the villi and by reducing the closure time.

To explain the closure phenomenon, STALEY (1971) proposed that it would start by a cessation of transfer of Ig through the cell membrane to the intercellular or subcellular space and then the transport of vacuoles containing Ig would stop

and eventually uptake by pinocytosis would stop. However, for STOTT et al (1980), it seemed that the contact with ingested colostrum immediately would incite pinocytotic activity, with the rapid uptake of available macromolecules into the cells, until a finite amount of pinocytotic activity would be reached. Then pinocytosis would stop and the transfer and release of macromolecules would continue through the remaining absorptive period until cessation occurred due to aging and maturation of the absorptive cells.

Effects of the different classes of immunoglobulins

LOGAN (1971 and 1974) has indicated that the three forms of Ig act at different sites in the calf. IgM when present in the blood prevents septicemia but has no influence on diarrhea. IgG is rapidly absorbed postnatally and during diarrhea is shed into the gut, suggesting a systemic and enteric function. IgA would be expected to be specifically involved in diarrhea but the evidence is not conclusive that it is quantitatively important.

ROY (1956) reported that dilute colostrum given after intestinal closure had a beneficial effect in reducing scouring and in preventing death in calves. He suggested that in the intestine, the antibodies of colostrum would act in a similar manner as in the blood. LOGAN and PEARSON (1978) found that the three classes of immunoglobulins were present in quantities on the surfaces of the intestinal villi and suggested that

these Ig would form an immunological barrier which would prevent the adhesion of enteropathogenic microorganisms. They also found in the same experiment that in 3 day old, colostrum-fed calves, some isolated epithelial cells did contain immunoglobulins, which suggested that they were still capable of limited absorption even in 4 day old calves.

Factors affecting the development of passive immunity

It is well known that there is a wide variability among calves concerning their immunoglobulin serum concentration. Even with careful handling, 30% of the dairy calves have been found to be hypogammaglobulinemic by KLAUS (1969), and LOGAN (1974) reported a rate of 23% of hypogammaglobulinemia for the suckled beef calves a few days after birth. The explanation that low concentrations result from a lack of colostrum absorption is valid for some cases, but not for all.

STOTT et al (1979) have shown that there is a significant positive correlation between the amount of colostrum fed up to 2 liters for Holstein calves, and for all the three classes of immunoglobulins. They found that calves fed 2 liters did not respond to a second feeding 12 hours after the first feeding whereas calves fed 0.5 or 1 liter responded. The calves fed 2 liters showed slightly higher absorption rate during the first period of 6 hours post feeding than those

fed with 0.5 and 1 liter. They also maintained much higher serum concentration than the latter. McEWAN et al (1970) noted a significant positive correlation between the amount of gammaglobulin ingested by the calves and the amount absorbed. KRUSE (1970) found that the increase of calf serum immunoglobulin concentration was primarily dependent on the mass of immunoglobulins given to the calf. BUSH et al (1971) observed that 68% of the variation in blood serum could be attributed to differences in amount of gamma globulin consumed per unit of weight. In another study (1973) he found that the concentration of immunoglobulins in the colostrum per se had a negligable effect. It is the mass of immunoglobulins consumed which was the primary factor.

KRUSE (1970) determined the importance of this factor in the concentration of Ig in the calf serum. The absorption coefficient was reduced linearly to about half by delaying feeding from 2 to 20 hours. In a field study, OXENDER et al (1973) reported a mortality rate of 7.6% for calves receiving colostrum within 6 hours of birth and 10% for those receiving it from 6 to 12 hours post partum. SELMAN (1973) found a great reduction in serum Ig of calves when feeding of pooled serum was delayed for 5 hours post-partum, and even lower for those deprived until 9 hours post partum. Working on the same subject, STOTT et al (1979) reported that after 12 hours the aging factor negatively influenced both the initial absorption rate during the first 4 hours after feeding and

the latter rate, but it did not seem to have any influence in the first 12 hours post-partum.

SELMAN (1973) fed equal amounts of colostrum to calves (mothered and nonmothered) and found that the mothering significantly increased by about 70% the 48 hours serum immunoglobulin concentration in calves. In a recent study, STOTT (1979) reported that the rate of absorption and maximum absorption were superior in calves that suckled regardless of age or amount of colostrum ingested compared with bottle fed calves. He found that the rate of absorption in suckled calves during the first 12 hours was nearly double that of bottle fed calves. He further found that suckled calves continued to absorb colostral Ig at nearly double the rate of the best absorption in bottle-fed calves and this for all classes of immunoglobulins. To explain this phenomenon, STOTT ruled out a psychological mothering effect but he believed that some labile factor was transferred to the calf in the fresh colostrum acting as a messenger to stimulate a burst of pinocytotic activity of the epithelial cells and a rapid transfer of the Ig to the systematic circulation. However, FRASER (1976) reported a study in which colostrum feeding was delayed for 18 hours in lambs while ewes were allowed to nuzzle their lambs in a wire cage. He found that 24 and 72 hours post-suckling, serum immunoglobulin concentrations were the same for lambs nursing immediately or delayed. So there may be a psychological factor involved in

colostrum absorption by neonatal ruminants.

TENNANT et al (1969) reported that in comparison of 1 day-old calves, Jersey calves had higher Ig concentration than Holstein calves. KRUSE (1970) showed that the Black and White Danish breed had absorbed equivalent doses of Ig more efficiently than the Red Danish breed. SELMAN et al in 1971 reported that they found a higher mortality rate in Aryshire calves (more than double) than in Freisians or Fresian-Ayrshire cross calves. But a management factor could have played a particular role in that experiment. HALLIDAY (1978) reported that Blue-Grey calves had a more rapid uptake of colostrum than the Hereford-Friesian calves.

JAMES (1970) reported that gammaglobulin uptake was greater in heavier calves. BRADLEY et al (1979) did not find statistically significant differences associated with birth weight and serum gammaglobulin concentration in calves. This finding has been also reported by KRUSE in 1970.

GAY (1965), SELMAN (1973) and McEWAN (1970) reported observations that the immunoglobulin status of calves is a reduced during the winter months. KRUSE (1970) found that there was little seasonal variation in yield or concentration of immunoglobulins and it was suggested by WARNER (1976) that the finding of more hypogammaglbulinemic calves during the winter could be explained by husbandry factors rather by an other phenomena.

Most of the studies relative to the effects of stress on

immunoglobulin absorption are related to the hyperadrenal state and the high concentration of circulating glucocorticoids during stressful situations. It seems that glucocorticoid does not have the same effect on the closure time as was described in rats. Some authors have described other stressful situations and most of them were unable to relate the effect of glucocorticoid concentration on gammaglobulin status. In 1978 STOTT and REINHART studying dystocial and eutocial calves found no difference in the absorption of IgA, IgM or IgG between the two groups. Feed deprivation was also studied and NIGHTENGALE (1979) reported that there was no significant relationship between the corticosteroid concentration of serum caused by inanition and the absorption of immunoglobulins. However in a study on the influence of environment on passive immunity STOTT et al (1975) found that calves exposed to the hotter, less desirable environment responded by having a high mortality, higher serum corticosteroid concentration and lower serum immunoglobulin IgG1 occurred at 2 and 10 days after birth. Concerning the effect of temperature, CABELLO and LEVIEUX (1980) found a negative correlation between the maximal IgG1 concentration and the outside temperature at birth. But they did not find a relation between the outside temperature at birth and the maximal serum concentration in IgM. In a previous study (1978) the same authors have found the same negative correlation with IgG1 and outside temperature. The calving occurred in stables,

but calves were immediately transferred outside to individual boxes. The minimal temperature reached during this experiment was -5c.

CABELLO and LEVIEUX (1978 and 1980) noted that it was generally recognized that the thyroid hormone influences the maturation process of the fetus and neonate studied the possible relation between perinatal thyroid function and intestinal absorption of immunoglobulins in calves. They found that hormonal iodine, T_3 and free thyroxine were significantly lower at birth as well as at 48 hours in healthy animals than in animals which later expressed diarrhea. They also found a negative correlation between plasma concentrations of hormonal iodine and TSH at birth, that the hyperthyroid state started before birth and that it was not related to the birth process. This fact is in agreement with what NATHANIELZ et al reported in 1974, when they described a negative correlation between thyroxemia at birth and the period of IgG1 absorption. According to MIDDLETON (1970), the thyroid hormones would hasten the maturation of the intestinal cells; a fact also demonstrated by MALINOWSKA et al (1974). However, CABELLO and LEVIEUX (1980), after having injected T_4 at birth on calves, were not able to find any noticeable alteration in the absorption of IgG1, but all the treated calves became ill independently of their IgG1 plasma concentration.

BALFOUR and COMLINES (1962) measured the absorption

of gammaglobulins administered with various media into the duodenum of anesthetized newborn calves. They found that very little labeled globulin was recovered when given in a solution of sodium, potassium, magnesium and calcium, wherease when administered with whey between 12% and 25% were recovered in the lymph within 5 hours. They found that inorganic phosphate, glucose-6-phosphate and a low molecular weight protein faction had a facilitating effect on the absorption. HARDY (1969) confirmed that factors in boiled colostrum whey were necessary for rapid absorption. Potassium isobutyrate was claimed by HARDY to be the most effective substance and at concentrations of 56.7 mole/liter it generally accelerated absorption more than colostral whey. However BAUMWART (1977) giving 2.83 meq of potassium isobutyrate in intact calves per gram of gammaprotein at the first feeding within 1 hour after birth found that isobutyrate had a depressing effect on the absorption of specific immunoglobulins IgG and IgM as well as on total gammaglobulins. FOLEY (1978) and HANGSLEBEN (1976) have reported lower serum Ig concentration in calves fed fermented colostrum than calves fed fresh or frozen colostrum from the same source. However, adjustment of the pH of the fermented colostrum to that of fresh colostrum resulted in an intermediate serum concentration. They also showed that there was little breakdown of colostral gammaglobulin and IgG during fermentation.

MATERIALS AND METHODS

This study involved 140 Hereford, Angus and Hereford X Angus heifers belonging to the Beef Research Center of the Kansas State University. The heifers were purchased at the age of 6-7 months in three lots from Nebraska, Missouri and Kansas in September 1978.

On receiving, they were randomly divided in two groups: Group A received a ration with 200 mg of monensin* per head per day for a 630 day period, the second group's ration (Group B) was not supplemented with monensin. The protein and energy levels of the diets of the two groups were identical for the period up to 100 days before parturition.

About 100 days before parturition, the two primary groups were divided again:

-- The monensin group was divided in Group 1A which received a low energy diet of 7.43 Mcal ME per head per day representing about 66% of the normal requirement, and group 1B which received a high energy diet of 11.41 Mcal ME per head per day representing about

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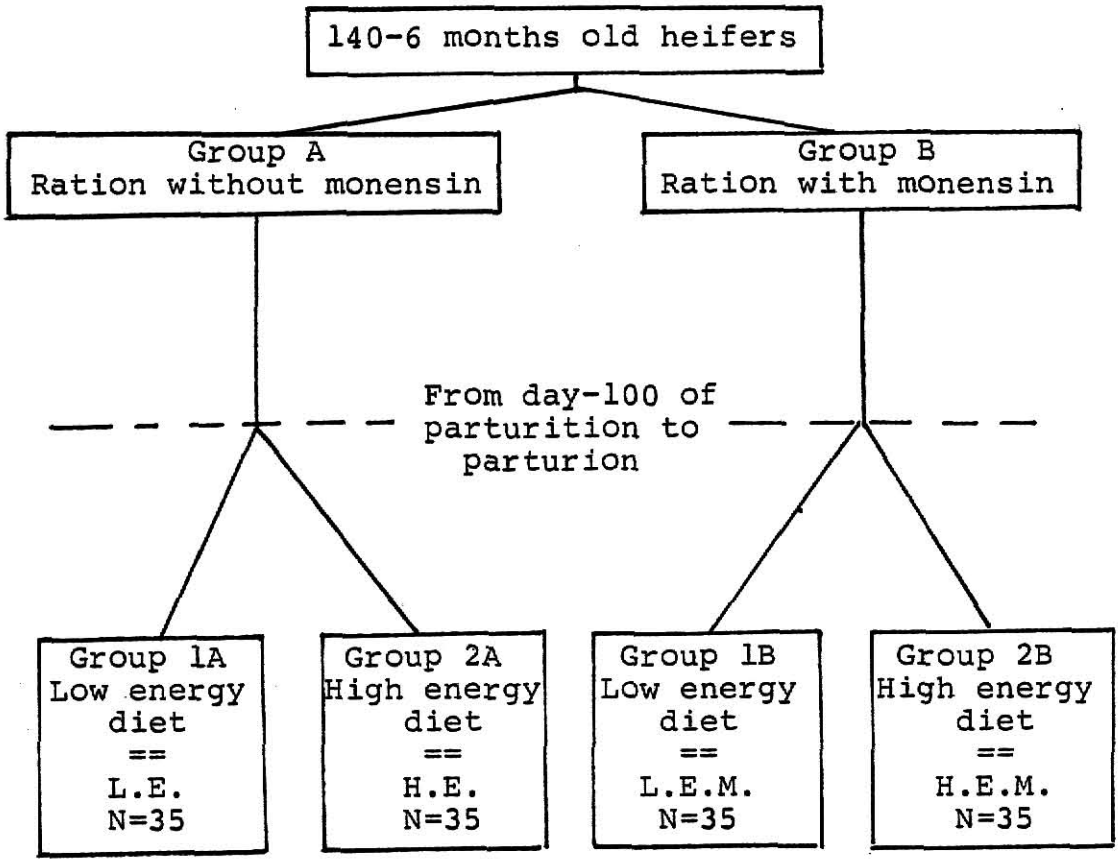
* Monensin: A biological active compound produced by Streptomyces cinnamonensis which was initially used as anticoccidial drug in poultry rations. Now it is used to increase feed efficiency in cattle by changing the rumen flora composition. It selects the growth of propionic acid forming bacteria. Increasing the production of this volatile fatty acid, which is a glucogenic one, increases the energy efficiency of the diet by about 10%. This product is marketed under the name of RUMENSIN by Elanco Company P.O. Box 1750, Indianapolis, Indiana 46026 U.S.A.

100% of the normal requirement.

--The non-monensin group was also divided following the same energy criteria into two groups: Group 1B consumed a low energy diet and group 2B consumed a high energy diet. (See Fig 1 below)

Fig 1: Grouping of the heifers according to their nutritional program.



The crude protein content of 1.35 lb per head and per day was the same for all groups. The animals were fed once a day.

The heifers were artifically inseminated during the summer of 1979 with the the semen from one Red Angus bull. The animals were confined in outdoor pens with access to a two-sided open shed for calving. The calving started on February 14, 1980 and ended on April 30, 1980. During this period 115 calves were born. The heifers were kept under close observation in order to assist the calving when necessary. The partum efforts were recorded and classified as follow:

1. Easy birth with no human assistance.
2. Manual assistance.
3. Delivery with a fetal extractor*
4. Caesarian section.

Following parturition the dams and calves were weighed. The umbilical cords were disinfected with 2% iodine solution. The calves were allowed to suckle their dams. If they had not nursed within the first 6 hours, they were bottle fed with the colostrum taken from their dams. It was assumed that the calves had suckled when they appeared clinically normal and full and when it was evident that the dams had been sucked.

Post suckling serum samples were collected by bleeding the calves from the jugular vein at 48 $\pm$ 6 hours post partum

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*Fetal extractor: from BOWIE Manufacture Company, Lake City, IOWA, U.S.A.

The blood samples were allowed to clot at room temperature then centrifuged and the sera removed and frozen at -20°C until analysis.

During September-October 1978 the heifers were vaccinated against:

- Infectious Bovine Rhinotracheitis and Parainfluenza 3[a] using instillation of 1 ml of vaccine in each nostril.
- Bovine Virus Diarrhea vaccination consisted of an intramuscular injection of 2 ml of vaccine[b].
- Clostridium chauvei, septicum, haemolyticum and novyi sordelli vaccine were given by subcutaneous injection[c].

They were also treated for lung worms using subcutaneous injections (2 ml/1b body weight) of Levasol[Rd]. A grubcide drug "Bo Ana"[Re] was poured on as directed.

Thirty days after receipt the animals were vaccinated against Brucellosis by subcutaneous injection of 5 ml of Brucella abortus vaccine strain 19[c] They were also vaccinated

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[a]Beecham Laboratories Bristol, Tennessee 37620, U.S.A.

[b]Dellen Laboratories, Omaha, Nebraska 68134, U.S.A.

[c]Jensen-Salsbery Laboratories, Division Burroughs Wellcome Company, Kansas City, Missouri 64141, U.S.A.

[d]Pitman-Moore Laboratory, Washington Crossing, New Jersey 08560, U.S.A.

[e]American Cyanamid Company, Princeton, New Jersey 08540, U.S.A.

against leptospirosis using 5 ml of vaccine[a] by intramuscular injection. This vaccine contained Leptospira canicola, L. grippotyphosa, L. hardjo and L. icterohaemorragiae strains.

Approximately one hundred and twenty days after receipt the animals were given a booster vaccination against Infectious Bovine Rhinotracheitis by intramuscular injection along with Bovine Virus Diarrhea and Leptospirosis vaccines. They received also an intramuscular injection of vitamin ADE[f]

Approximately one hundred and eighty days after receipt they were given a booster vaccination against Leptospirosis and a second treatment of vitamin ADE.

One half of the heifers were vaccinated against the thromboembolic-meningo--encephalitis[g] one year and three months after receipt. (2 months before the beginning of the calving season).

To measure the effect of cold weather on the immunoglobulin transfer, we used "wind chill" index. This index has been described by several authors (Insley 1972, Ames 1980) as giving a more accurate appreciation of the physiologic effect of cold than the temperature alone, since it takes in consideration the effect of the wind velocity. The wind chill index is de-

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[f]Pfizer, Department of Veterinary Medicine, New York, N.Y. 10017, U.S.A.

[g]Bio-ceutic Laboratory, St. Joseph, Missouri 64502, U.S.A.

fined as the combination of the dry bulb temperature and the air velocity under the mathematical form of a cubic equation for the bovine species:

$$Y=a+bX-cZ+dX_2^2-eX_3^3 \quad \text{where}$$

Y=is expressed in Kcal/day

X is the wind velocity in mph

Z is the temperature in ^{o}F

The "wind-chill" indexes were determined at the 3rd, 2nd and last week antepartum, at parturition and for the first 48 hours following the parturition. The following table gives some values utilized for the bovine species in winter months.

Temperature (^{o}F)

Wind Speed (mph)	-10	-5	0	5	10	15	20	25	30	35	40	45	50
Calm	-19	-5	0	5	10	15	20	25	30	35	40	45	50
5	-16	-11	-6	-1	3	8	13	18	23	28	33	38	43
10	-21	-16	-11	-6	-1	3	8	13	18	23	28	33	48
15	-25	-20	-15	-10	-5	0	4	9	14	19	24	29	34
20	-30	-25	-20	-15	-10	-5	0	4	9	14	19	24	29
25	-37	-32	-27	-22	-17	-12	-7	-2	2	7	12	17	22
30	-46	-41	-36	-31	-26	-21	-16	-11	-6	-1	3	8	13
35	-60	-55	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0
40	-78	-73	-68	-63	-58	-53	-48	-43	-38	-33	-28	-23	-18

(Personnal communication from D. Ames O.R. 1980)

The total direct and diffuse solar radiations were also measured for the same periods using a precision pyranometer[a] which had the capability to measure the radiations between the 285-2800 nm wavelength bands. The data expressed in

[a]Precision spectral pyranometer = EPPLEY. From Science Associates Incorported. 230 Nassan St. Box 230, Princeton, N.J. 08540 USA

Langley units*were recorded by the climatological station of the Kansas State University which is located near the place where this experiment was conducted.

The determination of the immunoglobulin concentration in calves serums were made using the radial-immunodiffusion technique described by MANCINNI and CARBONARA (1965).

This technique is based on the principle of an immune precipitin reaction between soluble antigen and its homologous antibody in an agar plate. It is performed by incorporating the antibody (rabbit anti-bovine immunoglobulins) uniformly throughout a layer of agar gel. The antigen (the immunoglobulin class content of the calf serum) diffuses radially out from wells punched in the agar plate, into the surrounding gel-antibody-mixture. A visible disc or ring of precipitate forms where the antigen and antibody have reacted. A linear relationship exists between the diameter of the precipitated ring and the concentration of the antigen, provided that diffusion has been allowed to proceed a sufficient time for antigen to combine. Prior to complete combination of antigen, the relation is curvilinear when the antigen concentration is plotted against the square of the diameter of the precipitate disc. The quantity of antigen present in the serum of unknown concentration (bovine immunoglobulin) can be estimated by

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*Langley units = $gmcal/cm^2$ for 24 hours.

comparison with results obtained using standard antigen preparations (bovine immunoglobulins) of known concentrations.

Concentration of IgG1, IgG2, IgM, and IgA in the calf serums were determined using commercial plates and standards from MILES Company*. Plates were also prepared using rabbit anti-bovine immunoglobulins from the same company and standards prepared in the K.S.U. laboratory.

Tris HCL buffer 12.11 g was used to dilute the agarose, ("TRIZMA BASE" from SIGMA CHEMICAL Company**) to which distilled water was added to make 1 liter. This solution was titrated using a pH meter with HCL 10 N to bring the pH to 7.4 ± 0.1.

Two and one-half grams of agarose "Type I Low EEO" from SIGMA CHEMICAL Company ** was diluted in a 125 ml Erlenmeyer flask with Tris buffer to make 100 ml and boiled in a boiling water bath to thoroughly dissolve the agarose. Two milliliters of 0.01% sodium azide*** was added to sterilize and protect the solution.

Lyophylised rabbit antiglobulin was reconstituted according the recommendations of the manufacturer (MILES Company) and then diluted with Tris buffer to a final concentration in the RID plate of 1/10 for IgG1 and IgG2 and 1/30 for IgM and

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*MILES LABORATORY Inc., Elkart, Indiana 46514 U.S.A.

**SIGMA CHEMICAL Company P.O. Box 14508, Saint Louis, Missouri 63178 U.S.A.

***FISHER SCIENTIFIC Company, 711 Forbes Avenue, Pittsburg, P.A. 15219 U.S.A.

IgA. Using a heated sterile pipette, 5 ml of diluted antiserum were dispensed in capped sterile 12 ml tubes placed in a 50°C water bath. They remained in the water bath for about 10 minutes as did the Erlenmyer flask containing the Tris-agarose solution to allow their temperature to stabilize at 50°C.

Empty RID plates from MILES were set on a level surface**** and were poured with the agarose antisera mixture as fast as possible to allow a level dispersion of the agarose over the surface of the plate.

The plates were set at room temperature for 5 minutes, then were covered and placed in a refrigerator for 5 to 10 minutes to harden.

Using a cutter and template (Code N°42 175 1 MILES) holes were punched into the agarose and the contained agarose was aspirated gently using a vacuum pump and a Pasteur pipette. The plates were then covered and stored upside down in sealed plastic bag at 4°C until ready to use.

The K.S.U. laboratory standard was prepared with bovine serum at different dilutions, preserved by adding 1 ml of 0.01% of sodium azide for 10 ml of serum. The dilutions were 1/4, 1/8, 1/16, 1/32, 1/64 for IgG1 and IgG2 and 1/2, 1/4, 1/8, 1/16 for IgM. The serum was obtained from an adult cow. Because

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****BIO RAD LABORATORY, 2200 Wright Avenue, Richmond, Cal. 94904, U.S.A.

the serum IgA concentration was too low in the cow's serum, nasal mucous secretion preserved with sodium azide at 0.01% was used as the IgA standard. The nasal secretion was concentrated three fold using AMICON B15 concentrator*. For the determinations of IgG1 and IgG2 subclasses, the test calf serums were diluted to 1/10 for IgG1 and 1/3 for IgG2. It was not necessary to dilute the test serums for IgA nor IgM determinations.

Plates were poured using normal or diluted serum according the the immunoglobulin classes. Micropipettes used were 10 ul for IgA and IgM plate and 5 ul for IgG1 and IgG2. The plates were placed in plastic bag and held at room temperature.

The plates were read on the 5th day. Oval rings were sometimes observed in the IgA plates. In this case, the mean of the two diameters was used as diameter of the reaction. Occasionally double or triple rings were observed mainly with locally poured IgG1 and IgG2 plates, but also on commercial plates and commercial standards. In this case the diameter of the larger ring was utilized.

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*AMICON CORPORATION, Lexington, Mass. 02173, U.S.A.

RESULTS

Statistical analysis were conducted by the Department of Statistics of the Kansas State University using the Statistical Analysis System*. Means, Standard Deviation, Least Squares Difference tests and Covariance Analysis were applied to study the effect of the different parameters.

During the study, one calf was born dead and premature. No etiology of the death was found. Three calves were born dead but at term. The cause of the death was prolonged dystocia. One calf died from exposure to cold. Two calves died because their dams laid on them. Three cows died following complication of caesarian section.

During May and June 1980, the calves presented three observation periods of illness during which 90 calves were treated and 10 calves died from pulmonary infection.

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*Statistic Analysis System Incorporated. SAS Circle, Box 8000, Cary, N.C. 27511, U.S.A.

Fig. 2 : IgG1 values for beef calves at 48 hours of age. Dams had received low or high energy prepartum diets with or without monensin corresponding to 66%, 76%, 100% and 110% of a normal energy requirement.

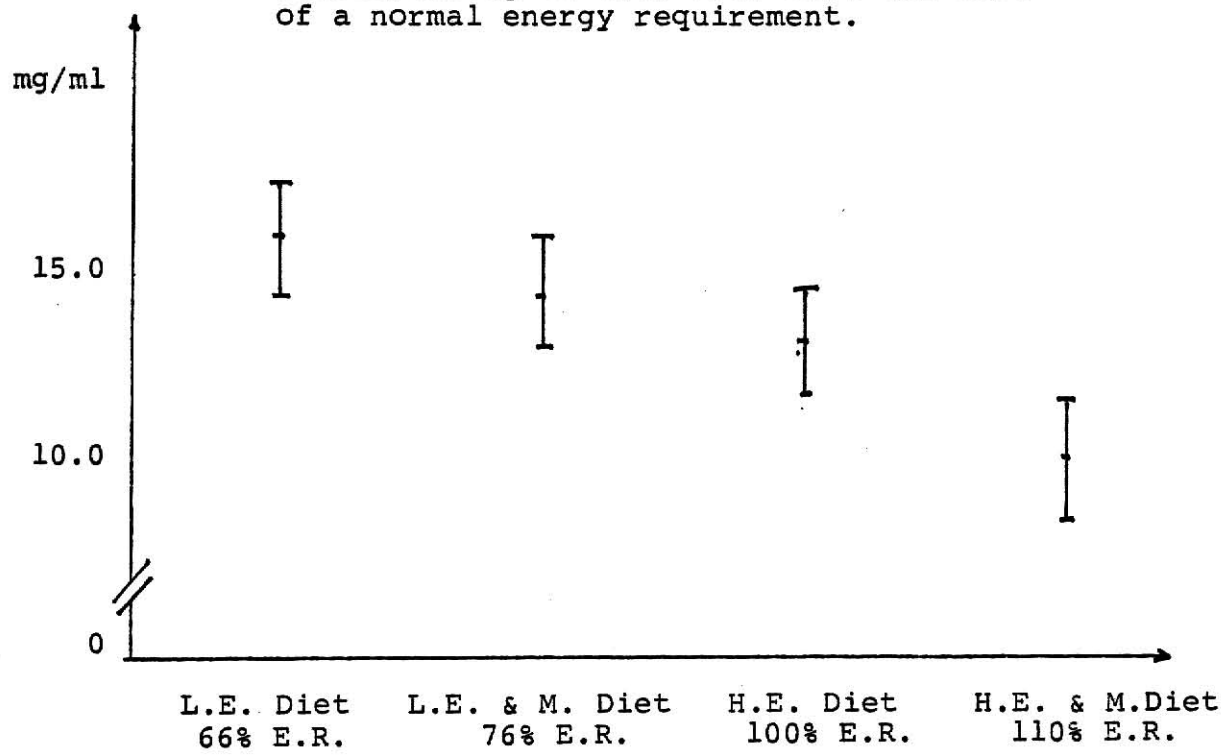

Fig. 3: IgM values for beef calves at 48 hours of age. Dams had received low or high energy prepartum diets with or without monensin. Corresponding to 66%, 76%, 100% and 110% of a normal energy requirement.

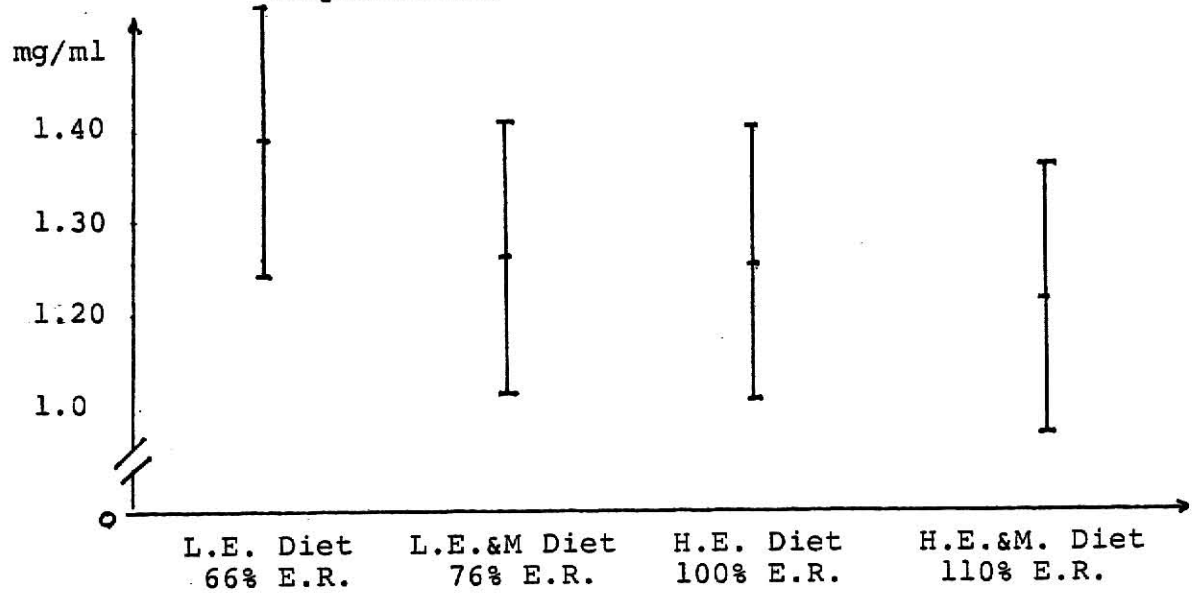

Fig. 4: IgA values for beef calves at 48 hours of age. Dams had received low or high energy prepartum diets with or without monensin corresponding to 66%, 76%, 100% and 110% of a normal energy requirement.

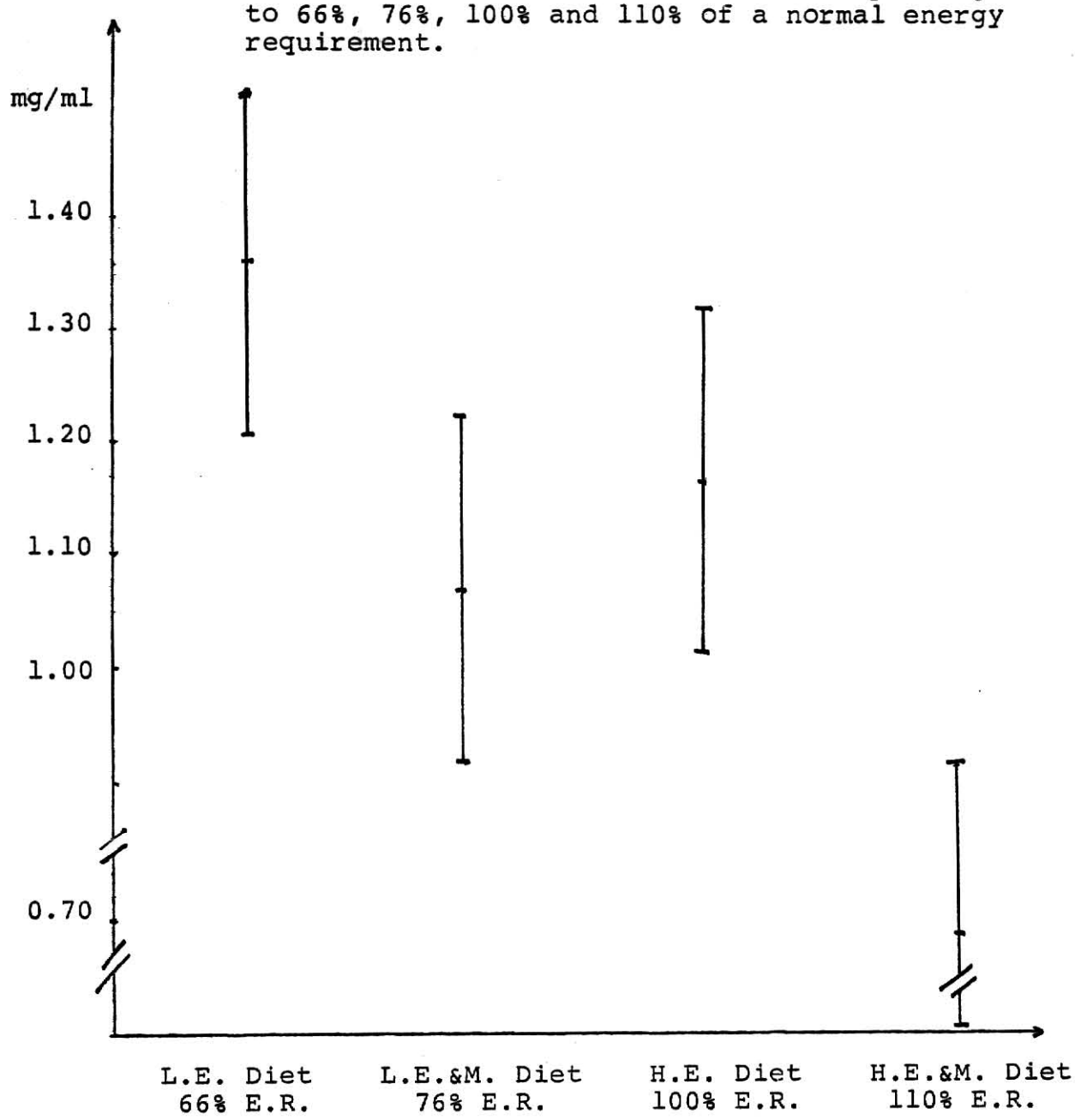

Fig. 5: IgG2 values for beef calves at 48 hours of age. Dams had received low or high energy prepartum diets with or without monensin corresponding to 66%, 76%, 100% and 110% of a normal energy requirement.

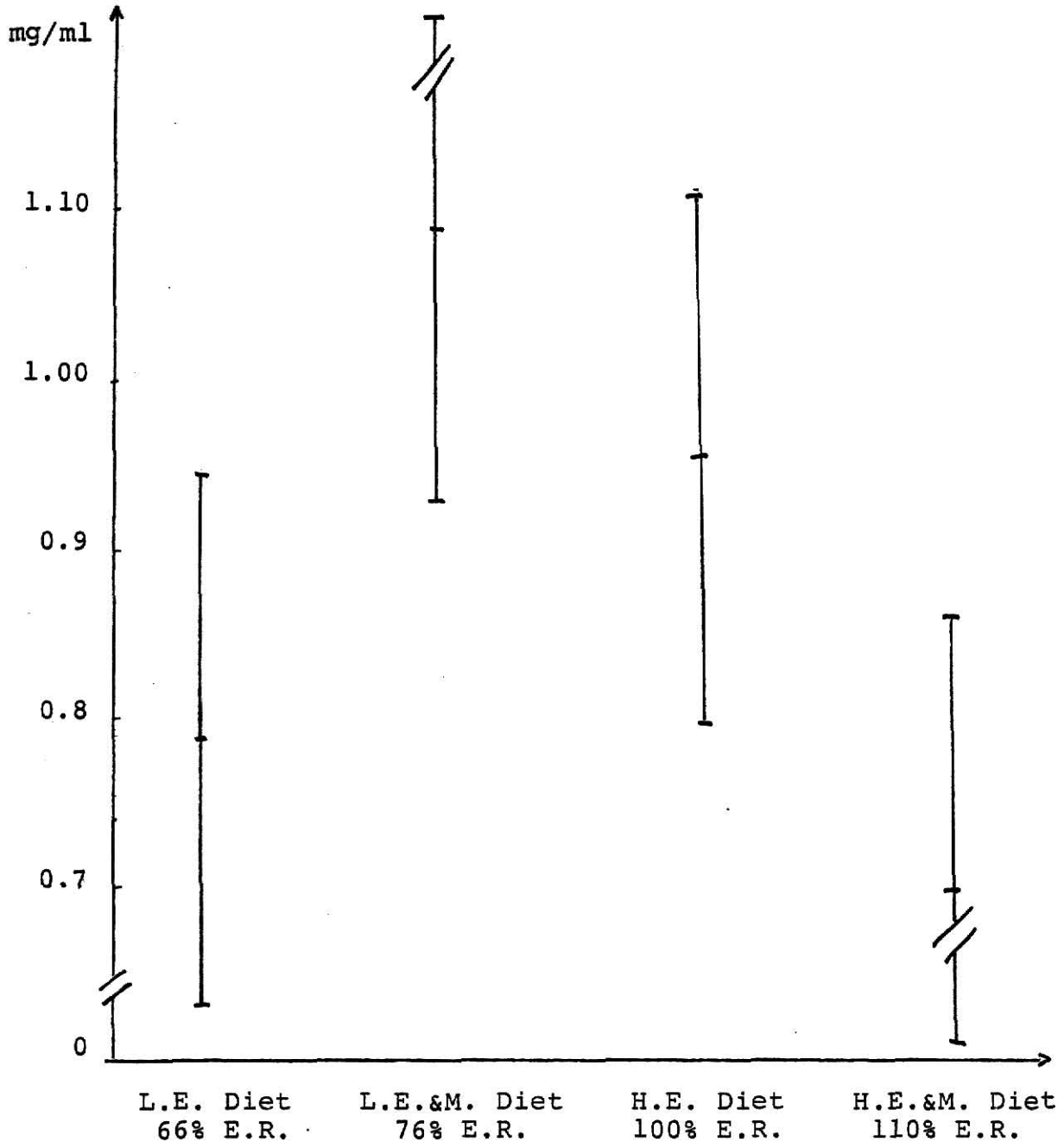

Fig. 6: Total Ig values for beef calves at 48 hours of age. Dams had received low or high energy prepartum diets with or without monensin corresponding to 66%, 76%, 100% and 110% of a normal energy requirement.

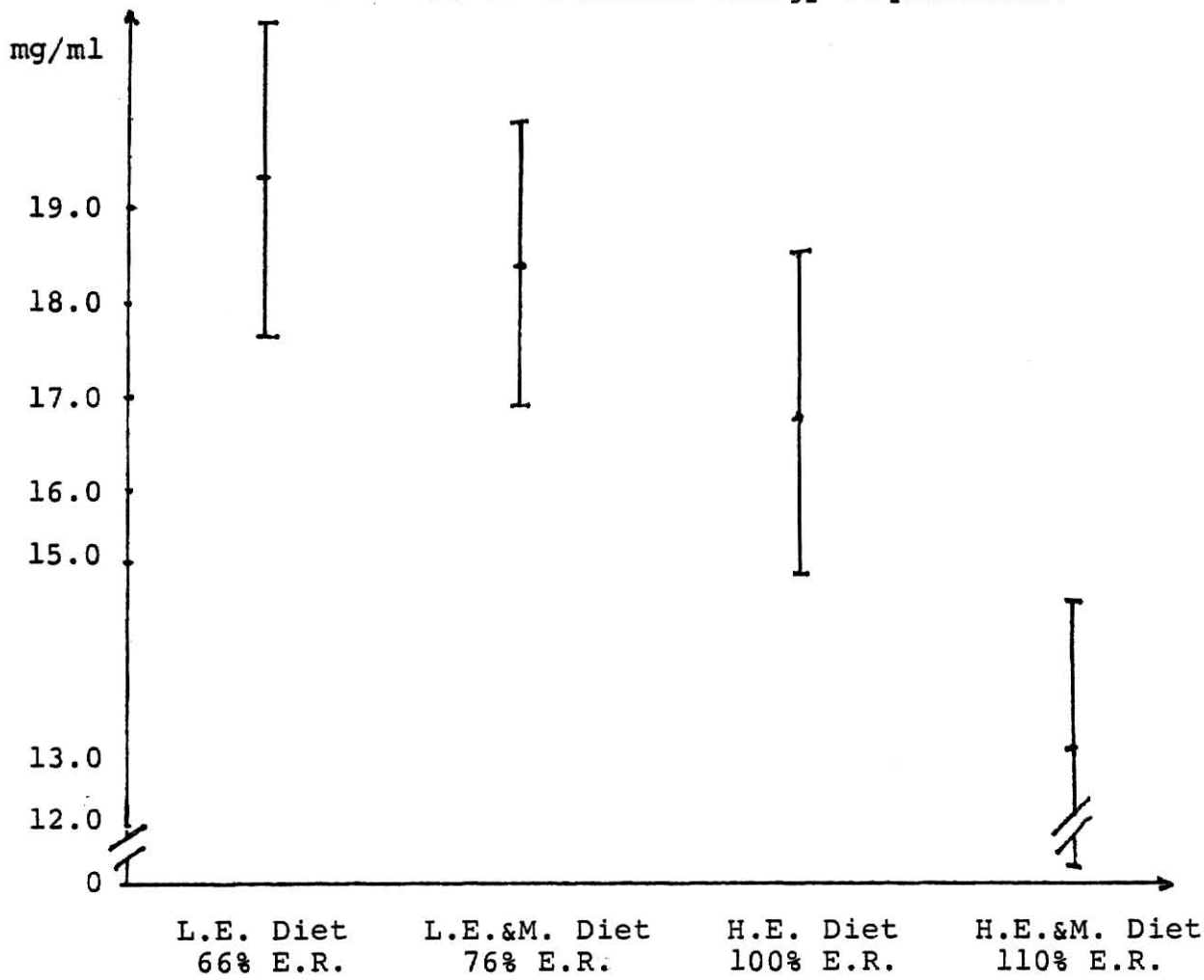

Table 1: Immunoglobulin values for beef calves at 48 hours of age. Dams had received high or low energy prepartum diets with or without Monensin. Means and standard deviation are shown.

Ig classes	L.E. diet	L.E.&M. diet	H.E. diet	H.E.&M. diet
IgG1	15.76 ± 1.47^{f}	14.86 ± 1.39^{f}	13.38 ± 1.42^{fg}	10.22 ± 1.39^{g}
IgM	1.39 ± 0.16^{e}	1.27 ± 0.15^{e}	1.26 ± 0.15^{e}	1.23 ± 0.15^{e}
IgA	1.36 ± 0.16^{c}	1.06 ± 0.15^{c}	1.17 ± 0.15^{c}	0.69 ± 0.15^{d}
IgG2	0.79 ± 0.13^{hi}	1.09 ± 0.12^{h}	0.95 ± 0.12^{hi}	0.70 ± 0.12^{i}
Total Ig	19.31 ± 1.72^{a}	18.29 ± 1.62^{a}	16.78 ± 1.66^{ab}	12.85 ± 1.63^{b}

Means with the same letter are not significantly different.

Table 2: Least square difference test of the relationship between dam's dietary treatments and calves serum immunoglobulin status at 48 hours of age.

Relation between diets	IgG1	IgM	IgA	IgG2	Total Ig
L.E. L.E.&M.	0.6564	0.5933	0.1719	0.0750	0.6690
H.E. H.E.&M.	0.1141	0.8818	0.0253*	0.1348	0.0937
L.E. H.E.	0.2473	0.5697	0.4002	0.3562	0.2923
L.E.&M. H.E.	0.4591	0.9678	0.5942	0.3797	0.5154
L.E. H.E.&M.	0.0074*	0.4723	0.0027*	0.5894	0.0076*
L.E.&M. H.E.&M.	0.0202*	0.8486	0.0826	0.0176*	0.0198*

*Significant at P 0.05

Table 3: Ig class values for beef calves at 48 hours of age. Dams were assigned randomly to a vaccinated group (*H.somnus* bacterin) and a non-vaccinated group.
Means, STD and L.S.D. are shown.

Ig Classes	Vaccinated N=51	Non-vaccinated N=52	PRO > (F)
IgG1	15.46±1.00	11.81±1.01	0.0121*
IgM	1.29±0.19	1.23±0.10	0.6889
IgA	1.14±0.11	0.97±0.11	0.2968
IgG2	0.89±0.08	0.87±0.09	0.8480
Total Ig	18.61±1.19	14.92±1.19	0.0304*

*Significant at P ≤ 0.65

Table 4: Ig Class values for beef calves at 48 hours of age with regard to whether they had nursed or were bottle-fed
Means, STD and L.S.D. are shown.

Ig Classes	Suckled calves N=96	Bottle-fed calves N=7	PRO > (F)
IgG1	13.60±0.75	6.31±3.98	0.0551
IgM	1.27±0.07	0.28±0.42	0.0234*
IgA	1.06±0.08	0.31±0.43	0.0949
IgG2	0.93±0.06	0.24±0.33	0.0434*
Total Ig	16.78±0.88	7.04±4.66	0.0427*

*Significant at P ≤ 0.05

Table 5: Effect of the sex of the calves on serum immunoglobulin class values at 48 hours of age. Means and LSD are shown.

Ig Classes	male N=47	female N=56
IgA	1.06[a]	1.01[a]
IgM	1.14[b]	1.34[b]
IgG1	13.09[c]	13.87[c]
IgG2	0.94[d]	0.83[d]
Total Ig	16.24[e]	16.90[e]

Means with the same letter are not significantly different.

Table 6: Effect of the delay of standing erect after birth on serum immunoglobulin class values of beef calves at 48 hours of age. Results of a covariance study are shown.

Ig Classes	Regression coefficient	PRO > (F)
IgG1	-0.2673 ± 0.6379	0.6762
IgM	-0.0350 ± 0.0659	0.5964
IgA	-0.1191 ± 0.0686	0.0860
IgG2	-0.0234 ± 0.6581	0.0527
Total Ig	-0.4064 ± 0.7411	0.5847

Table 7: Effect of delay of the first nursing on serum immunoglobulin class values of beef calves at 48 hours of age. Results of a covariance study are shown.

Ig Classes	Regression coefficient	PRO > (F)
IgG1	-0.2956 ± 0.2832	0.2992
IgM	0.0183 ± 0.0294	0.5346
IgA	-0.0362 ± 0.0307	0.2413
IgG2	-0.0024 ± 0.0234	0.0173*
Total Ig	-0.1972 ± 0.3304	0.3706

*Significant at $P \leq 0.05$

Table 8: Effect of the beef calf birth weight on their immunoglobulin class values at 48 hours of age. Results of a covariance study are shown.

Ig Classes	Regression coefficient	PROB > (F)
IgG1	-0.1842 ± 0.0830	0.0287*
IgM	-0.0138 ± 0.0086	0.1132
IgA	-0.0062 ± 0.0091	0.4912
IgG2	0.0010 ± 0.0068	0.8812
Total Ig	-0.2015 ± 0.0961	0.0403*

Significant at $P \leq 0.05$

Table 9: Effect of the beef calf birth weight on their immunoglobulin class values at 48 hours of age. Means, STD and LSD are shown.

Ig Classes	Calf weight 55 lb N=7	Calf weight 56lb 65lb N=41	Calf weight 66lb 75lb N=45	Calf weight 76 lb N=11
IgG1	18.24 ± 2.78^{a}	13.46 ± 1.15^{ab}	13.57 ± 1.09^{ab}	$10.32. \pm 2.21^{b}$
IgM	1.47 ± 0.29^{c}	1.28 ± 0.12^{c}	1.33 ± 0.11^{c}	1.00 ± 0.23^{c}
IgA	1.10 ± 0.30^{d}	1.16 ± 0.13^{d}	1.02 ± 0.12^{d}	0.82 ± 0.24^{d}
IgG2	0.74 ± 0.23^{e}	0.81 ± 0.10^{e}	0.97 ± 0.09^{e}	0.90 ± 0.18^{e}
Total Ig	21.55 ± 3.26^{f}	16.71 ± 1.31^{f}	16.90 ± 1.29^{f}	13.05 ± 2.8^{f}

Means with the same letter are not significantly different.

Table 10: Effect of parturition difficulty on the serum immunoglobulin class values of beef calves at 48 hours of age. Results of a covariance study are shown.

Ig Classes	Regression coefficient	PRO > (F)
IgG1	-2.1882 ± 0.8469	0.0112*
IgM	-0.2620 ± 0.0862	0.0030*
IgA	-0.1456 ± 0.0925	0.1188
IgG2	-0.0471 ± 0.0712	0.5098
Total Ig	-2.5660 ± 0.9889	0.0109*

*Significant at $P \leq 0.05$

Table 11: Effect of beef-dam weight at parturition on the serum immunoglobulin class values of their offspring at 48 hours of age. Results of a covariance study are shown.

Ig Classes	Regression coefficient	PRO > (F)
IgG1	-0.0057 ± 0.007	0.4008
IgM	0.0009 ± 0.0006	0.1677
IgA	-0.0005 ± 0.0007	0.4922
IgG2	0.0009 ± 0.0005	0.0985
Total Ig	-0.0046 ± 0.007	0.5648

Table 12: Effect of the beef-dam weight at parturition on the immunoglobulin class values of their offspring, at 48 hours of age. Means STD and LSD are shown.

Ig Classes	Dam's weight 550 lb N=6	Dam's weight 551-800 N=43	Dam's weight 801-900 N=34	Dam's weight 900 n=21
IgG1	9.68 ± 3.00^{a}	14.52 ± 1.12^{a}	14.18 ± 1.26^{a}	11.38 ± 1.60^{a}
IgM	0.50 ± 0.30^{b}	1.31 ± 0.11^{c}	1.35 ± 0.13^{c}	1.35 ± 0.16^{c}
IgA	0.83 ± 0.32^{d}	1.10 ± 0.12^{d}	1.15 ± 0.13^{d}	0.88 ± 0.17^{d}
IgG2	0.38 ± 0.24^{e}	0.83 ± 0.09^{f}	0.97 ± 0.10^{f}	0.98 ± 0.13^{f}
Total Ig	11.40 ± 3.51^{g}	17.78 ± 1.31^{g}	17.67 ± 1.47^{g}	14.60 ± 1.88^{g}

Means with the same letter are not significantly different.

Table 13: Effect of the dam "body-condition" score on the immunoglobulin class values of their offspring at 48 hours of age. Means and L.S.D. are shown.
Group A=body-condition 3,4
Group B=body-condition 4.5,5
Group C=body-condition 5.5,6,7
(Body-condition score varied from 1 for cachectic cow to 9 for obese cow).

Ig Classes	Group A N-17	Group B N-56	Group C N=30
IgG1	13.87^{c}	14.58^{cd}	8.85^{d}
IgM	1.30^{b}	1.26^{b}	0.97^{b}
IgA	1.49^{a}	1.09^{a}	0.73^{a}
IgG2	0.83^{e}	0.88^{e}	0.66^{e}
Total Ig	17.56^{f}	17.80^{fh}	11.20^{h}

Means with the same letter are not significantly different.

Table 14: Effect of the breed of the dams on the immunoglobulin class values of their offspring at 48 hours of age. Means and L.S.D. are shown.

Ig Classes	Angus N=26	AngusXHereford N=48	Hereford N=29
IgG1	16.85^{e}	12.61^{f}	11.86^{f}
IgM	1.61^{c}	1.18^{d}	1.04^{d}
IgA	1.46^{a}	0.93^{b}	0.83^{b}
IgG2	0.89^{h}	0.87^{h}	0.84^{h}
Total Ig	20.78^{i}	15.60^{j}	14.63^{j}

Means with the same letter are not significantly different.

Table 15: Effect of the diets on the weights and body condition scores of the dams at parturition. Means and STD are shown.

	Low energy diet N=26	Low energy diet + monensin N=27	High energy diet N=25	High energy diet + monensin N=25
Weights	748±841b[a]	764±811b[a]	842±731b[b]	858±901b[b]
Body condition score	4.48±059[c]	4.58±0.60[c]	5.18±043[cd]	5.52±055[d]

Means with the same letter are not significantly different.

Table 16: Effect of the wind-chill factor at birth on the immunoglobulin class values of beef-calves at 48 hours of age. Results of a covariance study are shown:

Ig Classes	Regression coefficient	PROB.> (F)
IgG1	-0.007 ± 0.013	0.5678
IgM	0.0001 ± 0.001	0.9352
IgA	-0.0004 ± 0.001	0.8249
IgG2	0.002 ± 0.0009	0.0159*
Total Ig	-0.0010 ± 0.017	0.5330

*Significant at $P \leq 0.05$

Table 17: Effect of the wind-chill factor during the first 48 hours post partum on the immunoglobulin class values of beef calves at 48 hours of age. Results of a covariance study are presented.

Ig Classes	Regression coefficient	PROB.$>$(F)
IgG1	-0.038 ± 0.027	0.0390*
IgM	-0.0006 ± 0.002	0.8191
IgA	-0.003 ± 0.001	0.0369*
IgG2	-0.002 ± 0.001	0.0578*
Total Ig	-0.043 ± 0.022	0.0562*

Table 18: Effect of the wind-chill factor during the week preceding parturition on the immunoglobulin class values of beef calves at 48 hours of age. Results of a covariance study are shown:

Ig Classes	Regression coefficient	PROB.$>$(F)
IgG1	-0.035 ± 0.032	0.2827
IgM	-0.003 ± 0.002	0.1385
IgA	-0.002 ± 0.003	0.4534
IgG2	0.005 ± 0.002	0.0160*
Total Ig	-0.031 ± 0.032	0.3380

*Significant at $P \leq 0.05$

Table 19: Effect of the "wind-chill" factor during the 2nd week preceding parturition on the immunoglobulin class values of beef calves at 48 hours of age. Results of a covariance study are shown:

Ig Classes	Regression coefficient	PROB. > (F)
IgG1	0.004 ± 0.118	0.910
IgM	0.014 ± 0.007	0.0576
IgA	0.015 ± 0.008	0.0635
IgG2	0.003 ± 0.009	0.7440
Total Ig	0.037 ± 0.089	0.6781

Table 20: Effect of the "wind-chill" factor during the 3rd week preceding parturition on the immunoglobulin class values of beef calves at 48 hours of age. Results of a covariance study are shown:

Ig Classes	Regression coefficient	RROB. > (F)
IgG1	0.050 ± 0.039	0.2101
IgM	0.020 ± 0.008	0.0231*
IgA	0.024 ± 0.009	0.0116*
IgG2	0.004 ± 0.008	0.6391
Total Ig	0.063 ± 0.044	0.1593

*Significant at $P < 0.05$

Table 21: Effect of the total solar radiation factor during the first 48 hours after birth on the immunoglobulin class values of beef calves at 48 hours of age. Results of a covariance study are shown:

Ig Classes	Regression coefficient	PRO.> (F)
IgG1	0.0013 ± 0.0006	0.0464*
IgM	0.0002 ± 0.00006	0.0039*
IgA	0.0001 ± 0.00007	0.0152*
IgG2	0.0001 ± 0.00005	0.8290
Total Ig	0.0018 ± 0.0008	0.0199*

Table 22: Effect of the total solar radiation factor during the first 24 hours after birth on the immunoglobulin class values of beef calves at 48 hours of age. Results of a covariance study are shown:

Ig Classes	Regression coefficient	PRO.> (F)
IgG1	0.0006 ± 0.00051	0.2298
IgM	0.0001 ± 0.00005	0.5881
IgA	0.0003 ± 0.00005	0.6758
IgG2	0.0002 ± 0.00004	0.3515
Total Ig	0.0008 ± 0.0006	0.1787

*Significant at $P \leq 0.05$

Table 23: Effect of the "total-solar -radiation" factor during the week preceding the parturition on the immunoglobulin class values of beef calves at 48 hours of age Results of a covariance study are shown:

Ig Classes	Regression coefficient	PROB.>(F)
IgG1	-0.0009 ± 0.0023	0.6691
IgM	-0.00049 ± 0.0002	0.0755
IgA	-0.0005 ± 0.0002	0.0619
IgG2	0.0002 ± 0.0001	0.0611
Total Ig	-0.0017 ± 0.004	0.6794

Table 24: Effect of the "total-solar-radiation" factor during the 2nd week preceding the parturition on the immunoglobulin class values of beef calves at 48 hours of age. Results of a covariance study are shown:

Ig Classes	Regression coefficient	PROB.>(F)
IgG1	0.0012 ± 0.0033	0.7162
IgM	0.0005 ± 0.0002	0.2975
IgA	0.0006 ± 0.0002	0.5932
IgG2	0.0002 ± 0.0003	0.5274
Total Ig	0.0003 ± 0.0060	0.9531

Table 25: Effect of the "total-solar-radiation" factor during the 3rd week preceding the parturition on the immunoglobulin class values of beef calves at 48 hours of age. Results of a covariance study are shown:

Ig Classes	Regression coefficient	PROB.>(F)
IgG1	0.0009 ± 0.0011	0.4111
IgM	0.00001 ± 0.00011	0.9862
IgA	-0.0001 ± 0.00008	0.1465
IgG2	-0.0002 ± 0.00008	0.7461
Total Ig	0.0008 ± 0.00013	0.5169

Table 26: Summary of the different factors having shown a significant effect on the immunoglobulin transfer in the current study. Results of correlation studies are presented.

Factors involved	IgG1	IgM	IgA	IgG2	Total Ig
Breed	0.0234*	0.0135*	0.0054*	0.9480	0.0158*
Vaccination H.somnus	0.0121*	0.6889	0.2968	0.8480	0.0304*
Calf weight	0.0287*	0.1132	0.4912	0.8812	0.0403*
Difficulty of birth	0.0112*	0.0030*	0.1188	0.5098	0.0109*
Body condition of the dams	0.0358*	0.8335	0.0487*	0.3921	0.0975
Solar radiation 48 hours	0.0464*	0.0039*	0.0152*	0.8290	0.0199*
Wind chill 48 hours	0.0390*	0.8191	0.0369*	0.0578*	0.0562*
Diet of the dams	0.0353*	0.8982	0.0198*	0.0868	0.0357*

*Significant at $P \leq 0.05$

Table 27: Ig class values for beef calves at 48 hours of age with regard to the observed periods of sickness. Means and STD are shown:

Ig Classes	1st period of sickness 18 calves sick	2nd period of sickness 13 calves sick	3rd period of sickness 65 calves sick
IgG1	14.40±8.23	14.32±8.55	13.78±7.64
IgM	1.18±0.68	1.17±0.75	1.26±0.77
IgA	1.01±0.77	1.00±0.76	1.07±0.80
IgG2	0.90±0.69	0.82±0.59	0.90±0.60
Total Ig	17.50±9.63	17.33±9.98	16.93±6.28

Table 28: Comparison between the immunoglobulin class values in 48 hours beef calf serum and the different periods of sickness. Results of a L.S.D. test are presented.

Ig Classes	1st period N=18	2nd period N=13	3rd period N-65
IgG1	0.6199	0.9747	0.8053
IgM	0.3142	0.8927	0.6430
IgA	0.8082	0.7221	0.1915
IgG2	0.8790	0.0793	0.3521
Total Ig	0.6898	0.8999	0.7583

Table 29: Ig class values for beef calves at 48 hours of age. Comparison between the healthy calves and those which died during the 2nd and 3rd observation period. Means and LSD are shown. (No calves died during the first observation period of sickness).

Ig Classes	Ig values of the healthy calves N-13	Ig values of the calves which died during the 2nd period N=3	Ig values of the calves which died during the 3rd period N=7
IgG1	15.33±1.54[a]	13.25±0.92[a]	13.67±4.45[a]
IgM	1.3±0.15[b]	1.23±0.09[b]	1.3±0.31[b]
IgA	1.12±0.16[c]	1.04±0.09[c]	1.01±0.30[c]
IgG2	1.00±0.12[d]	0.84±0.07[d]	0.72±0.23[d]
Total Ig	18.78±1.79[e]	16.39±1.07[e]	15.06+3.6[e]

Means with the same letter are not statistically different.

Table 30: Ig class values for beef calves at 48 hours of age. Comparison between sick calves which died and sick calves which survived during the 2nd and 3rd observation periods. Means and LSD are shown. (No calves died during the first observation period of sickness).

Ig Classes	Ig values for surviving calves 2nd period 100	Ig values for calves that died 2nd period N=3	Ig values for surviving calves 3rd period N-90	Ig values for calves that died 3rd period N=7
IgG1	14.32 ± 8.55^{a}	12.03 ± 4.45^{a}	13.78 ± 7.64^{a}	13.67 ± 4.54^{a}
IgM	1.17 ± 0.75^{b}	1.13 ± 0.44^{b}	1.26 ± 0.77^{b}	1.30 ± 0.31^{b}
IgA	1.00 ± 0.76^{c}	0.44 ± 0.46^{c}	1.07 ± 0.80^{c}	1.01 ± 0.30^{c}
IgG2	0.82 ± 0.59^{d}	1.06 ± 0.35^{d}	0.90 ± 0.60^{d}	0.72 ± 0.23^{d}
Total Ig	17.33 ± 9.90^{e}	15.16 ± 5.19^{e}	16.93 ± 6.28^{e}	15.06 ± 3.6^{e}

Means with the same letter are not statistically different.

DISCUSSION

The current study did show that serum immunoglobulin concentration in beef calves at 48 hours of age, presented large individual variations which were related to numerous factors. Within these factors which may have a potential effect on the immunoglobulin transfer, we investigated the effect of the diet of the dams during the late pregnancy, particularly related to the energy levels and the addition of Rumensin; the effect of the climatic environment particularly during the prepartum and partum periods with special references to the wind-chill effect and the total solar radiation effect.

The study involved 140 dam-calf pairs, but serum from only 103-48 hours old calves were obtained and analysed. Compared with immunoglobulin values reported by other authors (see table below) the Ig values found were in the lower range but still comparable considering that this study involved heifers which generally had lower colostral immunoglobulin concentration than multiparous cows (KRUSE, 1970, BRADLEY et al 1979). In comparing immunoglobulin values from earlier reports it must be kept in mind that such comparisons cannot be absolute, since the use of more pure reagents have generally resulted in values which are lower than 10 years ago. The earlier workers used the zinc sulphate turbidity test which had been standardized against solutions of barium

sulphate. But as J.M. Naylor (1979) reported, if this method allows comparison of data within the same laboratory, it does not allow comparison between different laboratories which generally use different modification of this test. These laboratory differences may increase the immunoglobulin values by a factor of up to 1.5, (Naylor, 1979).

With the radial immunodiffusion technique, the authors using the IgG immunodiffusion plates may have higher IgG immunoglobulin level than those using subclasses (IgG1, and IgG2) immunoglobulin plates. This observation was offered by Naylor (1979), who measured IgG value of calf serum using IgG plates and IgG1 and IgG2 plates. He found a mean of 10.8 mg/ml of IgG1, 1.2 mg/ml for IgG2 for a total for IgG of 12.00 mg/ml, which is very different from the value of 20 mg/ml, he obtained from the same serum using the IgG radial immunodiffusion plates.

IMMUNOGLOBULIN CLASS VALUES REPORTED BY AUTHORS HAVING WORKED IN COMPARIBLE EXPERIMENTAL SITUATIONS.

Ig Classes	*Logan et al 1974	**Logan et al 1978	***Halliday et al 1978	****Bradley et al 1979	Present Study
IgA	2.59±.69	2.04± .57	----------	----------	1.05± .78
IgM	2.48±2.08	4.03± .93	3.20± .24	----------	1.25± .77
IgG1	----------	----------	20.7±1.66	----------	13.59±7.26
IgG2	----------	----------	1.1± .10	----------	0.89± .59
Total IgG	30.90±17.28	21.5±2.6	----------	----------	----------
Total Ig	37.97± 7.01	27.57±1.02	----------	18.6± 5.9	16.59±8.53

*LOGAN et al 1974. Compared immunoglobulin class values on 11 Blue-Grey Charolais calves at 24 hours after birth. The dams were multiparous.

**LOGAN et al 1978. Compared immunoglobulin values at 48 hours after birth on 6 calves which were assisted to stand and encouraged to suckle to repletion between 30 and 60 min. post partum.

***HALLIDAY et al 1978. Compared immunoglobulin values on 31-48 hours old Hereford X Friesian calves without any specification of the dam's age.

****BRADLEY et al 1979. Compared total immunoglobulin values on 3 calves aged of 48 hours whose dams were Hereford heifers.

Effect of the prepartum diets

Many studies have been done on the effect of malnutrition on the susceptibility of humans and animals to many infections. This increase in susceptibility in malnutrition was related to the altered reactivity of the immune system (HUDSON 1973). However the mechanisms by which nutrition influences immunity is still not well known. It has been attributed to impaired immunoglobulin synthesis. However, this fact is balanced by the presence of concurrent infections which can enhance the circulating immunoglobulins. Serum Ig may be decreased, unchanged or even increased in malnutrition. (ALVARO et al 1971). It has been shown that high protein diets can favor production of blocking antibodies which may interfere with the activity of immune lymphocytes and delay homograft rejection (JOSE & GOOD 1971). Malnutrition also affects the cell mediated system through different mechanisms:

- an increase of a C-reactive protein, depresses lymphocyte responsiveness in vitro and would affect the lymphoid system in vivo (GOLDBLUM et al 1972).
- a decrease in circulating growth hormone will also effect the lymphocyte system (PANDIAN et al 1971).
- a decrease in transferrin has an effect on the growth and transformation of lymphocytes in vitro (McFARLANE et al 1970, TORMEY et al 1972).
- an increase in circulating corticosteroid hormones (WOODRUFF 1972) may result in lympoid tissue atrophy.

Woodruff reported similar atrophy from other factors.

Protein and energy deprivation in utero has been found to have a profound effect on the immunological maturation of the offspring, even when subjects are fully relaimented. Kennedy (1969) reported that a severe reduction of food intake in mice and rats resulted in thymolymphatic atrophy, reduced cell-mediated immunity and impaired antibody response to sheep red blood cells. The immune response was found to be depressed in the first and second generation of offspring of deprived dams (CHANDRA 1975). Few studies have been reported concerning the effect of the energy intake in late pregnancy in cattle and its effect on the passive immunoglobulin transfer to the offsprings. HALLIDAY et al (1978) reported no significant difference between dams having received high or low energy diets.

In the current study, higher immunoglobulin values were found for all imunoglobulin classes except for IgG2 (Table 1) for calves which dams had received the low energy rations compared with those which dams were on high energy diet. However the difference between the energy levels,"sensus stricto" was not statistically significant. The addition of monensin to either the low or high energy prepartum diets did not effect significantly the 48 hours calf serum immunoglobulin mean values except for IgA where a significant lower concentration was found with the high energy diet with monensin. (Table 1)

Significant higher IgG1, IgG2 and total immunoglobulin mean values were noted in calves which dams had received low energy diet with monensin compared with those which dams were on the high energy ration with monensin. (Table 2)

Significantly higher IgG1, IgA, and total immunoglobulin concentrations were found in calf serums which dams had received low energy diet without monensin compared with those which dams had received the high energy diet with monensin. (Table 1-2)

If we consider that the addition of monensin to the prepartum diets had the principal effect of increasing the energy efficiency of the ration by about 10% (which itself can be controversial) we can make the hypothesis that adding monensin to the low energy level would increase the energy available from 66% to 76% of the normal requirement. Adding monensin to the high energy diet would also increase the energy available from 100% to 110% of the normal energy requirement. Then analysis of the data showed that there was a constant decrease in the immunoglobulin transfer for all the immunoglobulin classes except for the subclass IgG2 when passing from the lower energy ration to the higher one (Fig 2-3-4-5-6.) This finding would signify that the prepartum energy intake would have a significant effect on all immunoglobulin classes except for IgM for which the difference was not significant. A more efficient immunoglobulin transfer would be expected with low energy prepartum rations for all

immunoglobulin classes (fig 2-3-4-6) except for IgG2 (fig 5). We will discuss again this hypothesis and its consequences latter when referring to the dam weight and body condition at parturition, and the effect of wind-chill.

Effect of the calf weight at birth:

The results of the covariance study (table 8) shows that the calf weight at birth has a significant effect on the transfer of IgG1 and total immunoglobulin concentration at 48 hours of age. The negative value of the regression coefficient indicates that the correlation is negative for the IgA, IgM, IgG1 and total Ig. The data suggests that as the calf weight increases the immunoglobulin transfer is less efficient.

When the calf weights are distributed in 4 classes from weight inferior to 55 lb to weights superior to 76 lb, (table 9) higher immunoglobulin concentration were noted in all immunoglobulin classes except for IgG2 for the lower mean weights.

This finding is different from that reported by KRUSE (1970) and BRADLEY (1979) however, other authors (DARDILLA T.J. et al 1969) have reported that calves with either low or high weight at birth had generally lower immunoglobulin concentration than calves within the mean range. They related the lowest concentration for the heavy calves to the stress resulting of the increase difficulty of parturition and for the light calves for a kind of insufficient vitality.

In this study, the light and heavy class calves were relatively few (18 together compared with 86 for the mean weight). The standard deviations (table 9) are greater in light and heavy classes than those in the middle classes. A possible explanation is that the low or high weight classes were more heterogenous.

Effect of the sex of the calves

The IgM, IgG1, and total immunoglobulin concentrations appeared to be higher in the serum of the female calves than in the male calves (table 5). However, this difference was not statistically significant.

Similar finding have been reported on lambs (SAWYER et al 1977). Differences in immunological status between sexes have been reported (TERRES et al 1968, ROWLEY et al 1969). Enhanced antibody production and concentration of serum immunoglobulin have been observed in females in comparison with concentration in control groups of males (BUTTERWORTH et al 1967). Even if it is sometimes controversial it has been shown that both natural and synthetic estrogen may enhance the activity of the reticuloendothelial system and result in increased antibody formation (MAGARREY et al 1971). On the other hand, testosterone is clearly immunossupressive and induces involution of the lymphoid tissue. So it seems that the influence of sex hormones is well established for mature animals. Data from this study

would suggest that significant effects of sex on immunoglobulin transfer is lacking in the young immature animal.

Effect of the delay of standing and nursing

The delay of the calf to stand after birth was noted in order to document the vitality of the calf. The range of this delay was 15 minutes to 4.30 hours with a mean at 45 minutes.

The results (table 6) showed that there was no significant difference in the immunoglobulin transfer for all immunoglobulin classes except for IgG2. The covariance study for IgG2 was shown to be close to statistical significance ($P < 0.0527$). However, the negative value of the regression coefficient indicated that as the time of standing increased, the transfer was less efficient.

The study of the delay of first nursing which was in a range of 20 minutes to 11 hours showed a significant difference for the subclass IgG2 but not for the other immunoglobulin classes. A negative correlation was found for all immunoglobulin classes except for the IgM class. (table 7)

The lack of significant difference between the calves which nursed early with those which nursed later could be explained by the fact that this delay was still within the normal range of time where closure of the intestinal epithelium cells had not yet occurred. Additionally the quantity of colostrum each calf had absorbed was not known. This fact would be

very important in relation to the immunoglobulin concentration of the calf serum.

Effect of bottle feeding

Although there were insufficient number of bottle-fed calves (7 calves compared with 96 which nursed their dams) to make valid comparisons between these two classes of calves, the results can be seen in the table 4. The bottle-fed calves had remarkably low immunoglobulin values in all classes.

This finding is comparable with what is now well known if not yet explained on the effect of suckling on the absorption of the lactoglobulins by the neonatal calf. SELMAN (1973) reported an increase of about 70% in the 40 hours serum immunoglobulin concentration in mothered calves. STOTT (1979) reported that the rate of absorption in suckled calves during the first 12 hours was nearly double that at birth and even latter compared with the bottle-fed calves. He proposed the hypothesis that some labile factor must be transferred to the calf in fresh colostrum which would stimulate a burst of pinocytosis activity of the epithelial cells of the intestine of the calf. A second explanation would be that mothering may have a psychological effect on the calf accompanied by a neuro hormonal response which would have an effect on the intestinal absorption. Currently there are no facts to support the hypothesis that a labile

factor is present in the colostrum directly suckled at the udder and not when colostrum is bottle-fed. However, HARDY (1969) reported that there are solvent factors in the colostrum which accelerate absorption of the lactoglobulin. On the other hand, FALLON (1978) noted that artifically feeding calves in the presence of their dams result in a significant increase in the calf's blood serum Ig concentration with the same uptake of colostrum.

Effect of parturition difficulty (dystocia)

The covariance study of the increased difficulty of parturition showed a negative effect on the immunoglobulin transfer of all Ig classes, with a significant difference for IgM, IgG1 and total Ig (table 10). This finding differs from that of STOTT & REINHARD (1978) in their report on the effect of dystocia on the immunoglobulin transfer. They reported similar absorption of IgA, IgG and IgM in both dystocial and eutocial calves. However, because their main purpose was to compare the intestinal absorption of the Ig, they bottle fed the calves 1 liter of pooled colostrum at 4 hours and 12 hours after birth. They did not take into consideration the effect of dystocia on the quality and quantity of colostrums nor the effect of lack of nursing which very often happens in the stressed dystocial mother. Then the 2 experiments are not totally comparable.

Effect of the breed of the dams

Higher immunoglobulin concentrations were found in all immunoglobulin classes in Angus and Angus X Hereford breeds than in the pure Hereford breed. (Table 14) The difference was statistically significant between the Angus breed and the other breeds. This finding is comparable with what BRADLEY (1979) reported concerning lower Ig concentration in the Hereford breed than in the hybrid breed. HALLIDAY (1978) also had reported that the Blue Grey calves had a more rapid uptake of the colostrum Ig than the Hereford-Friesian calves.

Consequently it seems that in the same environment and with the same management the effect of the breed of the dam could play an appreciable role in the immunoglobulin transfer. This would probably be of genetic origin.

Effect of the vaccination of the dam

The vaccination of the dam during the prepartum period with a bacterin against Hemophilus somnus, increased the concentration of IgG1 and total Ig in statistically significant ways. (Table 3) This finding confirms what several authors particularly GAY C.C. et al (1964) SNODGRASS et al (1980) have reported on the positive effect of the vaccination of the dams before parturition on the serum antibody concentrations of their suckled offsprings.

However, such a significant increase was more than ex-

pected. It is possible that part of the effect might be related to nonspecific stimulation of the immune system of the dams rather than to the specific response to a specific antigen Hemophilus somnus. Further work utilizing precipitation of the specific antibody for Hemophilus somnus would be required to ascertain the precise effect.

Effect of the weights and body conditions of the dams at parturition

The covariance study did not show any significant effect of the dams weight on the serum concentration of the overall immunoglobulin. (Table 11). However, by grouping the dam's weights in 4 classes (Table 12) a significant difference was shown for the IgM and IgG2 classes between the lower weight and higher weight mothers. Thus it seems that the weight of the cows may play a role in the transfer of IgG2 and IgM class with lower efficiency transfer for the lower weights.

Since a part of the weight of the cows comes from fat deposition in case of excessive energy intake, it is of interest to consider the importance of the fat deposition through the "body-condition" criteria in the immunoglobulin transfer. Body condition was determined and classified in a scale ranging from 1 for a cachectic cow to 9 for an obese cow.

Significant differences were found between the highest body condition scores and the other groups for IgG1, and total Ig. Higher concentrations were noted in animals with

lowest body condition scores. The weights and body condition scores were directly related to the effect of the diets (Table 15) but when the weights and body condition scores are compared it appears that the deposition of fat on the body has a negative effect on the immunoglobulin transfer, and it is the fat deposition rather than weight which has the major effect. It is of interest to note that from an "animal-husbandry" point of view, even the cows with the highest body condition scores were not considered as obese, and that their diet, consisted of the high energy level with monensin, was only 110% of what is considered as the normal energy requirement for this type of animal.

CHANDRA (1977) noted "that there is a fixed relationship between protein requirement and basal energy requirement and that these must be balanced if the animal is to be in the optimum physiologic state to resist infectious disease". Perhaps the same thought can be applied to the transfer of passive immunity from the dam to the offsprings. It is also interesting to note that BRADLEY (1979) reported "a non expected significant difference (P 0.05) between the serum immunoglobulin values of 48 hour old calves from selected and non-selected Shorthorn dams. "The highest concentration having been within the non-selected group" the selection having been made for many years on the yearling weight increasing substantially the selected dams weights and certainly their body condition. NEWBERNE (1971) reported that obese animals

did not respond to viral and bacterial aggression as well as normal animals. He related this fact to an impairment of the reticuloendothelial system.

Environmental effect

Among elements of the physical environment, climate and weather seem to have most profound influences on disease resistance and the immunological status. Many infectious or immunological disorders of man and domestic animals show seasonal cycles presumably associated with the thermal environment (TROMP 1963, TOP 1964).

Cold exposure has been shown to enhance infections of mice with trypanosomes and virus (MARCUS et al 1964, OTIENO 1972). ST ROSE et al (1971) reported faster catabolism of antigen and earlier appearance and higher levels of circulating antibodies in cold-exposed groups. KAUFMAN et al (1966) reported increased phagocytic activity during cold exposure.

Several authors (STOTT 1975, CABBELLO 1978-1980) have reported that the ambient temperature at birth and in the hours following birth had an appreciable role in the immunoglobulin transfer. Several authors also have advanced the hypothesis that stress before parturition on the dams would have even a greater effect on immunoglobulin transfer. (HUSBAND 1973, MULLER et al 1975 - STOTT et al 1980).

So it was of interest to see if stresses imposed by the weather during prepartum periods would have some effect on

the immunoglobulin transfer.

"Wind-chill" effect

At birth the wind chill did not show a statistical significance except for IgG2 which is decreased as the "wind-chill" increased in negative values. The negative value of the regression coefficient for IgA IgG1 and total Ig indicated a negative correlation and that transfer was better in the lower range of the temperatures. The fact that the value of the regression coefficient is very low indicates that the variation is not very important (Table 16). During the first 48 hours, the effect of the wind chill was statistically significant for IgG1 and IgA, with values close to significance for IgG2 and total Ig. There was no significant difference for IgM. Again the same relation of a negative correlation with the same signification was noted. This finding seems to confirm the work of CABELLO & LEVIEUX (1978, 1979) on the effect of cold weather on the immunoglobulin transfer.

During the week preceding parturition, only the IgG2 showed a significant difference (Table 18). Negative values were noted for all regression coefficients except for IgG2.

In the second week preceding parturition, the negative value of the regression coefficient disappeared and except for IgG2 a difference close to significance for IgA (P 0.065) and IgM (P 0.057) was noted. It seems that during this

period, the warmer climate would have a positive effect on the immunoglobulin transfer of IgA and IgM.

In the third week preceding parturition, the difference is significant for IgA and IgM, but not for the other classes. The value of the regression coefficient is greater than what was found for the wind chill at birth and at 48 hours after calving indicating that the effect at this time may be more important.

In this particular study, it seems that the weather would have had a significant effect 3 weeks ante partum on the IgA and IgM classes with an increase in the transfer at the higher temperatures, the second critical period seems to be the first 48 hours following the birth, and in this case, IgG1, IgA and perhaps IgG2 and total Ig would transfer better under cold conditions.

Several hypothesis may be proposed to explain this phenomenon. It has been shown that injection of corticosteroids or induced natural corticosteroids through stress to the newborn calf or to its dam in late pregnancy did not affect the immunoglobulin transfer, as reported in mince. However, injection of long acting corticoids to the dam several days before parturition produced an effect by decreasing the intestinal absorption of Ig. These observations would suggest that maturation of the intestinal epithelial cells would occur sooner and at a greater extent under conditions of stress. In the present study, it seems that stress resulting from

cold during the 3rd week before parturition may play a role in the maturation of the epithelial cells resulting in a decrease of the Ig absorbed after birth. It is interesting to note that from one week before parturition to 48 hours after parturition we found a negative correlation between the temperature or wind chill and the immunoglobulin transfer. Two mechanisms may have played a role; one at the level of the dam or in relation to the dam and the other concerning the calf itself.

The data suggests that the highest body condition score was related to a less effective transfer and that body condition was more directly related to the level of the energy intake. Since one of the major effects of cold environmental temperature is an increase in the energy requirement, the hypothesis advanced previously concerning an eventual effect of energy on the immunoglobulin transfer is still valid. As the "wind'chill" increased in negative values, the energy requirement for basal metabolism increased and the heifers were in an energy status similar to those which would have received a lower energy diet.

The maintenance energy requirement for animals exposed to cold has been described to be on the form of the following equation: (AMES 1980)

$Me_m = aW^{\cdot 75} + b\frac{T}{I}$ where:

Me_m = metabolizable energy for maintenance corrected for effective temperature (kcal ME/day)

T = magnitude of cold, i.e., difference between animal's lower critical temperatures and effective temperature.

I = total insulation (C/kcal/m^2/day)

a = coefficient "a" is 127.8 Kcal ME/day for cattle and sheep.

Using this equation for a 500 kg heifer exposed to an effective ambient temperature of -15^{o}C it can be calculated that the energy requirement in such a decrease in ambient temperature is about 4,000 kcal ME/day. If this compensation is not forthcoming then a high energy diet will become essentially a low energy one. During the immediate period preceding parturition the cow will consume less food which would also decrease the energy intake. It is possible that chilling of calf affects the neurohormonal reflexes involving the hypothalamus and the intestinal immunoglobulin absorption by a mechanism affecting the increase of central blood circulation, (W. J. TIETZ 1977). A second long term effect involving the hypothalamus-adrenal-thyroid axis is their role in increasing the metabolic activity of the calf, which in turn increases its need for energy and additional suckling.

Effect of the total solar radiation

Data concerning the total solar radiation showed a significant effect on the IgA, IgM, IgG1 and total immunoglobulin values, for the first 48 hours after birth but not during the first 24 hours (Table 21-22).

It should be recognized that the method of recording the "solar radiation for the first 24 hours" after calving may not have reflected exactly the quantity of solar radiation effectively received by the calf. If the calf was born at 6PM the data would show as if it had received the solar radiation of that day when in fact it had not received any. Consequently, the data is biased for the first 24 hour period. This problem is attenuated during the next period since the calf would have received at least 12 hours of solar radiation. Since intestinal closure occurs effectively within the first twenty four hours it may well be that those recorded as having been exposed to solar radiation in 48 hours really were affected by solar radiation during the first twenty four hours. The study of the regression coefficient showed that there was a positive correlation between the solar radiation and the immunoglobulin transfer, however, that the effect is probably not very important since as the solar radiation increased by one unit the total immunoglobulin concentration was increased by 0.0018 mg (Table 21). The covariance study for the periods preceding parturition (Tables 23-24-25) did not show significant differences.

COMPARISON BETWEEN THE DIFFERENT FACTORS HAVING SHOWN A SIGNIFICANT EFFECT ON THE IMMUNOGLOBULIN TRANSFER

A covariance study to compare the effect of the different factors which were significant (Table 26) is summarized by the

following table. The factors are listed in order of decreasing effect.

IgG1	IgM	IgA	IgG2	Total Ig
Difficulty of parturition	Difficulty of parturition	Breed of dams	Wind chill 48hr.	Difficulty of parturition
Vaccination of the dams	Solar radiation 48 hours	Solar radiation 48 hours	Wind chill 1 wk A.P.	Solar radiation 48 hours
Breed of the dam	Breed of the dam	Diet of the dam		Breed of the dam
Calf weight at parturition		Wind chill 48 hours		Vaccination of the dam
Prepartum diet		Body-condition of the dam		Diet of the dam
Wind chill at 48 hours				Calf weight
Solar radiation 48 hours				

It is of interest to note that the different classes and subclasses of immunoglobulins did not seem to be affected in a same fashion by the various factors studied in this experiment. Prepartum vaccination of the dams had a significant effect on the IgG1 subclass values but not on the other Ig.

Difficulty of parturition seems to have an important role for IgG1 and IgM but not for the other immunoglobulins.

The breed of the dam affected essentially the IgA but and a lesser effect on IgG1 and IgM.

The prepartum diet is important for the IgA class, less important for IgG1, and had no significant importance for IgM and IgG2.

Solar radiation seemed to have the most effect on the IgM and IgA classes.

These different responses of the different immunoglobulins are not surprising, as we contemplate the important differences concerning biochemistry, origin, and evolution of the specific immunoglobulins and their movement, which involves at least five mechanisms: Passage from the blood of the dam, secretion in the udder, movement of colostrum from udder to the calf, the passage into the calf's digestive tract, the absorption by the intestinal cells and transfer to the plasma. Each of these steps is under the control of numerous factors involving neurohormonal reflexes and feedback mechanisms. Each of which might affect the immunoglobulins in different ways depending on their biochemical and biological properties.

Relation between the diseases occurring in the calves and their 48 hour serum immunoglobulin values

During May and June 1980, the calves experienced 3 periods of illness.

The first observation period started on May 2nd and ended on May 9th. This period was characterized by pneumo-enteritis in the calves. Laboratory diagnosis confirmed IBR (5 cultures postive) and Pasteurella hemolyticum. The number of calves affected were 99 with no deaths registered

during this period.

The treatment of the calves consisted of chloramphenicol* injections (5 mg/lb subcutaneously) once daily. The average length of treatment was 3.62 days (range 2-13 days).

The second observation period started on May 12th and ended on May 20th. This period was characterized by an outbreak of keratoconjontivitis in 15 heifers with pneumonia in some calves. Seventeen calves were treated for pneumonia. Three calves died during the second period. Laboratory tests were negative for Moraxella bovis, viral cultures were negative for IBR, BVD; and FA was negative for IBR.

The third observation period started on May 23rd and ended on June 19th. The illness was characterized by severe respiratory signs including dyspnea, serous nasal discharges, depression, and anorexia with temperature ranging up to 108^{o}F. Seventy three calves were treated during this period with an antibiotic combination consisting of Tylan^{R} (10mg/lb)** and oxtetracycline (5mg/lb)***. The average length of treatment was 4.2 days (range 1-11 days). Seven calves died. No laboratory testing was done at this time. Pasteurellosis was suspected.

The data did not reveal any significant relationship between the Ig class values in 48 hours calf serum and the

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incidence of illness in the 3 observation periods previously defined. (Tables 27-28).

Relation between the healthy calves and those which died during the 2nd and 3rd observation periods

There was a suggested difference at 48 hours in immunoglobulin values between the calves which died after pneumonia and those which remained healthy through the illness period. Higher Ig values were found for all Ig classes in the serum of the calves which remained healthy. However, this difference was not statistically significant. (Table 29).

Relation between those calves surviving an illness and the calves which died during the 2nd and 3rd observation periods

The 48 hour Ig values of the surviving calves appeared higher for all Ig classes except for IgG2 when compared to the values for these calves which died during the same period. But again this difference was not statistically significant, in either period. (Table 30)

In this study, the results did not show a relationship between the incidence of a respiratory syndrome in 2 to 3 months old calves and their immunoglobulin concentrations at 48 hours of age.

This finding differs from the hypothesis proposed by WILLIAMS, et al (1975). Williams et al reported that passive immunity obtained by colostrum ingestion would have an effect on the resistance of calves to respiratory diseases up to 5 months of age. However, their hypothesis was based

on immunoglobulin measurements on 2.5 weeks old calves and not on 48 hours old calves. So the two studies are not really comparable. Recent studies (VESTWEBER 1980) suggests that in case of enzootic pneumonia, subclinical viral infections may occur soon after birth. Such calves express respiratory problems much later at (4 or 5 months of age). This observation may explain the observations of WILLIAMS better than the direct effect of the colostral immunoglobulin transfer on the occurence of pneumonia 5 months later. The calves with high serum Ig concentration at 48 hours of age would might resist the first viral infection and might prevent the virus from developing, thus preventing the "long pneumonic process". In the present study, pneumonia was caused mainly by IBR virus which may have been transmitted by cattle brought into neighboring pens a few days before the first episode of pneumonia.

SUMMARY

Data on concentration of serum immunoglobulins in the 48 hours old beef calf were subjected to statistical analysis in order to estimate what factors could significantly affect the immunoglobulin transfer.

- IgG1 transfer was significantly increased by the vaccination of the dams with Hemophilus somnus bacterin 2 months prior parturition, by the increase of total solar radiations and decrease of the wind-chill index during the first 48 hours post partum.

The transfer was significantly decreased by high energy prepartum diets with monensin, following increased parturition difficulty, in association with the increased calf birth weights and in calves whose dams were of pure Hereford breed.

- IgM transfer was significantly increased for calves whose dams had the highest weight at parturition. It was significantly increased with the increase in total solar radiation during the first 48 hours post partum, and the increase in the postive value of the wind-chill index during the 3rd week preceding parturition.

The IgM transfer was significantly decreased by increased parturition difficulty and in the Hereford breed.

- IgA transfer was significantly increased in association with the increase of total solar radiation and decrease in wind-chill index during the first 48 hours postpartum.

It was significantly decreased by high energy prepartum diet with monensin, with the increase of the dam body condition score at parturition and in the pure Hereford breed.

- IgG2 transfer was significantly increased by the increase in negative values of the wind-chill index during the first 48 hours after parturition and in the week preceding parturition. It was significantly decreased by the increase in the delay of standing and nursing for the calves after birth.

From the results it is apparent that the immunoglobulin classes were not affected to the same degree by the various factors studied in this experiment. This study further showed that the effect of each factor individually was not very important and could not explain by itself the lack of immunoglobulin transfer. It was the combination of several negative factors occurring simultaneously which produced the lack of efficiency in immunoglobulin transfer.

REFERENCES

1. ALVARO J.; LUTHRINGER D.G.: (1971) Serum immunoglobulins in edematous protein-calorie malnutrition. Clin. Pediat. 10 174.

2. AMES D.R.: (1980) Livestock nutrition in cold weather Animal Nutrition and Health 39 6.

3. BALFOUR W.E,: COMLINE R.S.: (1962) Acceleration of the absorption of unchanged globulins in the new-born calf by factors in colostrum. J. Physiol 160 234.

4. BARTA O.: BARTA V.: INGRAME E. AND HUBBERT W. (1972) Bactericidal activity of bovine fetal serum against smooth and rough strains of Escherichia Coli Am. J. Vet. Res. 33 731.

5. BARRAT M.E.J.: PORTER P. Immunoglobulin classes implicated in intestinal disturbances of calves associated with soya protein antigen. The J. of Imm. (1970) 676.

6. BAUMWART A.L.: BUSH L.J.: MUNGLE M.: CORLEY L.D. : (1977) Effect of potassium isobutyrate on absorption of immunoglobulins from the colostrum by calves. J. Dairy Sc. 60 752.

7. BERNE B.H.: (1974) Differing methodology and equations used in quantitating immunoglobulins by radial immunodiffusion. A comparative evaluation of reported and commercial techniques. Clin. Chem. 20 61.

8. BRADLEY J.A.: NILLO L. AND DORWARD W.J.: (1979) Some observations on serum gammaglobulin concentrations in suckled beef calves. Can. Vet. J. 20 227.

9. BRAMBELL F.R.: (1970) The transmission of passive immunity from the mother to young. American Elsevier Publishing Company New York.

10. BRANDON MR.: LASCELLES A.K.: (1971) Relative efficiency of absorption of IgG1, IgG2, IgA and IgM in the newborn calf. Aust. J. Exp. Biol. Med. Sc. 49 629.

11. BRIGNOLE T.J.: STOTT G.H.: (1979) Colostrum feeding after closure. Annual meeting An. Dairy Sc. UTAH State University 1979.

12. BROCK J.H.: PINEIRO A.: LAMPREAVE F.: (1978) The effect of trypsin and chemotrypsin on the antibacterial activity of complement antibodies and lactoferrin in bovine colostrum. Ann. Rech. Vet. 9 287.

13. BULLEN J.J.: ROGERS H.J.: LEIGH L.: (1972. Iron binding proteins in milk and resistance to E. coli infection in infants. Brit. Med. J. 1 69.

14. BUTLER J.E.: (1974) Immunoglobulin of the mammary secretion Vol. III BL Larson and VR Smith Ed Academic Press New York.

15. BUTTERWORTH M.: Mc CLELLAN B. and ALLANSMITH M.: (1967) Influence of sex on immunoglobulin levels. Nature Lond. 214 1224.

16. BUSH L.J.: AGUILERA M.A.: ADAMS G.D. and JONES E.W.: (1971) Absorption of colostral immunoglobulins by the new born calf. J. Dairy Sc. 54.

17. BUSH L.J.: MUNGLE M.B.: CORLEY L.DL: ADAMS G.D.: (1973) Factors affecting absorption of immunoglobulins by new born dairy calves. J. Dairy. Sc. 56 312.

18. BUSH L.J.: STALEY TLE.: (1980) Absorption of colostral immunoglobulins in new born calves. J. Dairy Sc. 63 672.

19. CABELLO G.: LEVIEUX D.: (1978) The effects of thyroxine and climatic factors on colostral gammaglobulin absorption in new born calves. Ann. Rech. Vet. 9 309.

20. CABELLO G. and LEVIEUX D.: (1980) Comparative absorption of colostral IgG and IgM in the new born calf. Ann. Rech. Vet. 11.

21. CHANDRA R.N.: (1975) Antibody formation in first and second generation offspring of nutritionally deprived rats. Science 190 289.

22. CHANDRA R.K.: NEWBERNE P.M. N1077 Nutrition, immunity and infection mechanisms of interact plenum press. New-York, N.Y. 10011.

23. CHANDRAN R.C.: SHAHANI K.M.: HOLLY R.G.: (1964) Lysozyme content of human milk. Nature 204 688.

24. DARDILLAT J.: BROCHARD M.: LARVOR P.: (1969) Relations entre la quantite d'unites fourrageres consommees par

des vaches charollaises en fin de gestation et le poids corporel apres velage, le poids de naissance et la mortalite des veaux. C. R. Acad Agri. Fr. 55 1016.

25. DELOUIS C.: (1978) Physiology of Colostrum production. An. Rech. Vet. 9 193.

26. DEUTSCH: (1957) Intestinal permeability to protein in the new born herbivore. Am. J. Phys. 191 271.

27. DEVERY J.E.; DAVIS C.L.; LARSON B.L.: (1979) Endogenous production of immunoglobulin IgG in newborn calves. J. Dairy Sc. 62 1814.

28. EL-NAGEH M.M.: (1967) Voies absorption des gamma-globulines du colostrum au niveau de 1 intestin grele du veau nouveau ne. Ann. Med. Vet. 6 384.

29. FALLON R.J.: (1978) The effect of immunoglobulin levels on calf performance and methods of artifically feeding colostrum to the newborn calf. Ann. Rech. Vet. 9 347.

30. FEY H.: (1971) Immunology of the newborn calf: its relationship to colisepticemia. Ann. N.Y. Acad. Sc. 176 49.

31. FOLEY J.A.; HUNGER A.G.; OTTERBY D.E.: (1978) Absorption of colostral proteins by newborn calves fed unfermented, fermented or buffered colostrum. J. Dairy Sc. 61 1450.

32. GAY C.C.; ANDERSON N.; FISHER E.W.; and McEWAN A.D.: (1965) Gammaglobulin levels and neonatal mortality in market calves. Vet. Rec. 77 148.

33. GEWURZ H.; PICKERWG R.; and GOOD R.: (1968) Complement and complement components. Int. Arch. Allergy 33 369.

34. GOLDBLUM R.M.; and GOLDMAN A.S.: (1972) C-reactive protein, lymphocyte transformation, and protein-calorie malnutrition. Lancet 1 495.

35. HALLIDAY R.: (1959) The effect of steroid hormones on the absorption of antibody by the young rat. J. Endocrinology 18 56.

36. HALLIDAY R.; RUSSEL A.J.F.; WILLIAMS M.R.; PEART J.N.: (1978) Effect of energy intake during late pregnancy and of genotype on immunological transfer to calves in suckler herds. Res. Vet. 24 26.

37. HANGSLEBEN C.; McCOY G.C.; and STRACK L.E.: (1976) Effect of fermentation of gammaglobulin content of bovine colostrum. J. Dairy Sc. 59.

38. HARDY R.N.: (1969) The influence of specific chemical factors in the solvent on the absorption of macromolecular substances from the small intestine of the new born calf. J. Phys. 204 607.

39. HEAD J.R.; and BEER A.E.: (1978) The immunologic role of viable leucocytic cells in mammary exosecretions. A comprehensive treatise Vol. Iv BL LARSON Ed. Acad Press N.Y.

40. HENRY C.; and JERNE N.K.: (1968) Competition of 19S and 7S Antigen receptors in the regulation of the primary immune response. J. Exp. Med. 128 133.

41. HILL I.R.; PORTER P.: (1974) Studies of bactericidal activity to E. coli of porcine serum and colostral immunoglobulins and the role of lysozyme with secretory IgA immunology 26, 1239.

42. HUDSON R.J.; (1973) Reduced immunologic responsiveness in parasitic infections Adv-Vet. Sci. 17 87.

43. HUSBAND A.J.; BRANDON M.R.; LASCELLES A.K.: (1972) Absorption and endogenous production of immunoglobulins in calves. Aust. J. Exp. Biol. Med. Sci. 50 491.

44. HUSBAND A.J.; BRANDON M.R.; LASCELLES A.K.: (1973) The effect of corticoid on absorption and endogenous production of immunoglobulins in calves. Aust. J. Exp. Biol. Med. Sc. 51 707.

45. Effect of orally administration of duodenal fluid on susceptibility of newborn calves to E. coli challenge. J. Dairy Sc. 59 1495.

46. JAMES R.E.; POLAN C.E.: (1978) Effect of orally administered duodenal fluid on serum proteins in neonatal calves. J. Dairy Sc. 61 1444.

47. JAMES R.E.; POLAN C.E.; McGILLIARD M.L.: (1979) Distributed uptake of Ig in small intestine of neonatal calves. J. Dairy Sc. 62 1415.

48. JOSE D.G.; and GOOD R.A.: (1971) Absence of enhancing antibody in cell mediated immunity to tumor heterografts

in protein deficient rats. Nature, Lond 231 323.

49. KAUFMAN H.M.; and NORTHEY W.T.: (1968) Effect of hypothermia on leukocytic phagocytosis in rabbits. Aerospace Med. 39 717.

50. KENNEY M.A.; MAGEE J.L.; and PIEDAD-PASCUAL F.: (1970) Dietary aminoacids and immune response in rats. J. Nut. 100 1070.

51. KLAUS, G.; BENNETT A.; and JONES E.: (1969) A quantitative study of the transfer of colostral immunoglobulins to the newborn calf. Imm. 16 293.

52. KRAFHENBUHL J.P.; RACINE L.; and GALARDY P.E.: Localization of the secretion of the IgA secretory component in the mammary gland of lactating rabbits by immunoelectron microscopy. Ann. N.Y. Acad. Sc. 254 190.

53. KRUSE V.: (1970) Yield of colostrum and immunoglobulins in cattle at the first milking after parturition. Animal Prod. 12 619.

54. KRUSE V.: (1970) Absorption of immunoglobulins from colostrum in newborn calves. An. Prod. 12 627.

55. KRUSE V.; BUUS O.: (1972) Corticosteroids in cow and calf at parturition. Acta. Vet. Scand. 13 585.

56. LAMOTTE G.R.; EBERHART R.S.: (1976) Blood leucocytes, neutrophil. phagocytosis and plasma corticoids in colostrum fed and colostrum deprived calves. Am. J. Vet. Res. 37 1189.

57. LARSON B.L.; and KENDALL K.A.: (1957) Changes in specific blood serum protein levels associated with parturition in the bovine, J. Dairy, Sc. 40 659.

58. LARSON B.L.; HEARY H.L.; and DEVERY J.E.: (1980) Immunoglobulin production and transport by the mammary gland. J. Dairy Sc. 63 665.

59. LASKOWSKI Jr.; LASKOWSKI M.: (1951) Crystalline trypsine inhibitor from colostrum. J. Biol. Chem. 190 563.

60. LAW B.A.; REITER B.: (1977) The isolation and bacteriostatic properties of lactoferrin from bovine milk whey. J. Dairy Res. 44 595.

61. LEARY H.L.; LECCE J.G.: (1976) Uptake of macromolecules by enterocytes on transposed and isolated piglet small intestine. J. Nutr. 106 419.

62. LECCE J.G.: (1973) Effect of dietary regimen on cessation of uptake for macromolecules by piglet intestinal epithelium and transfer to the blood. J. Nutr. 103 751.

63. LECCE J.G.; BROUGHTON C.W.: (1973) Cessation of uptake of macromolecules of neonatal guinea pig, hamster and rabbit intestinal epithelium and transport into blood. J. Nut. 183 744.

64. LINZELL J.L.; PEAKER M.: (1974) Changes in colostrum composition and in the permeability of the mammary epithelium at about the time of parturition in the goat. J. Phys. 243 129.

65. LOGAN F.F.; McBEATH D.G.; LOWMAN B.G.: (1971) Studies on the immunity of the calf to colibacillosis. Vet. Rec. 88 222.

66. LOGAN F.F.; PENHALE J.J.: (1971) Studies on the immunity of the calf to colibacillosis. Vet. Rec. 89 628.

67. LOGAN E.F.: (1972) Changes in the serum immunoglobulin levels of colostrum fed calves during the first 12 weeks post partum. Res. Vet. Sci. 14 394.

68. LOGAN E.F.; STENHOUSE A.; ORMROD D.J.; PENHALE W.J.: (1974) The role of colostral immunoglobulins in the intestinal immunity to enteritic colibacillosis in the calf. Res. Vet. Sc. 17 290.

69. LOGAN E.F.: (1975) Serum immunoglobulin levels in suckled beef calves. Vet. Rec. 97 229.

70. LOGAN E.F.: (1977) The influence of husbandry on colostrum yield and immunoglobulin concentration on beef cows. Br., Vet. J. 133 120.

71. LOGAN E.F.; PEARSON G.R.: (1978) The distribution of the immunoglobulins in the intestine of the neonatal calf. Ann. Rech. Vet. 9 319.

72. LOMBA L.; FUMIER E.I.; TSHIBANGU M.; CHAUVAUX G.; and BIENFET V.: (1978) Immunoglobulin transfer to calves and health problems in large bovine units. Ann. Rech. Vet. 9 353.

73. LOMBARDO P.S.; TODHUNTER D.A.; SCHOLZ R.W.; EBERHART R.J.: (1979) Effect of colostrum ingestion on indices of neutrophile phagocytosis and metabolism in newborn calves. Am. J. Vet. Res. 40, 362.

74. MALINOWSKA K.W.; CHAN W.S.;NATHANIELSZ P.W.; HARDY R.N.: (1974) Plasma adrenocorticoid changes during thyroxine induced accelerated maturation of the neonatal rat intestine. Experientia 30 61.

75. MANCINI G.; CARBONARA A.O.; and HEREMANS J.F.: (1965) Immunochemical quantitation of antigens by single radial immunodiffusion. Immunochemistry Perganon 1965. 12 235.

76. MAGARREY L.S.; and BAUM M.: (1971) Oestrogen as a reticuloendothelial stimulant in patients with cancer Br. Med. J. 2 367.

77. MARCUS S.; and MIYA F.: (1964) Effect of different routes of challenge of coesackie B. virus on cold-stressed mice. Artic aeromed. Mab. Fort Wainwright Alaska. Rep. AAL_TED 642.

78. McCOY G.C.; RENEAN J.K.; HUNTER A.G.; and WILLIAMS J.B.: (1970) Effect of diet and time on blood serum proteins in the newborn calf. J. Dairy Sc. 53 358.

79. McEWAN A.D.; FISHER E.W.; SELMAN I.E.: (1970) Observations on immunoglobulin levels of neonatal calves and their relationship to disease. J. Comp. Path 80 259.

80. McFARLANE H.; REDDY S.; ADCOCK K.J.; ADESHINA H.; COOKE A.R.; and AKENE J.: (1970) Immunity, transferrin and survival in Kwashiorkor. Br. Med. J. 4 268.

81. MIDDLETON W.R.J.: (1971) Thyroid hormones and gut. Gut. 12 172.

82. MOHR J.A.; LEU R.; and MABRY W.: (1970) Colostral leukocytes J. Surg. Oncol. 2 163.

83. MULLER L.D.; BEARDSLEY G.L.; ELLIS R.P.; REED D.E.; and OWENS M.J.: (1975) Calf response to the initiation of parturition in dairy cows with dexamethasone or dexamethasone with estradiol benzoate. J. Animal Sci. 41 1711.

84. NATHANIELSZ PLW.; COMLINE R.S.; SILVER M.; THOMAS A.L.: (1974) Thyroid function in fetal calf. J. Endoc. 61 IXXI.

85. NATHANIELSZ P.W.: (1975) Thyroid function in the fetus and newborn mammal. Brit. Med. Bull 31 51.

86. NAYLOR J.M.: (1979) Quantitation of immunoglobulins in calf serum. Vet. Rec. Jan. 1979.

87. NEWBERNE P.M.: (1971) Influence of obesity on response of dogs to infection. Proc. Small. Al Nut. Workshop University of Illinois Coll. of Vet. Med.

88. NIGHTENGALE G.T.: (1979) The effects of delayed feeding on serum corticoid concentrations and their relationship to immunoglobulin absorption in the calf. Thesis University of Arizona, Tucson.

89. OSBORN B.I.: (1974) Perinatal immunity in calves. J. Am. Vet. Ass. 164 295.

90. OTIENO L.H.: (1972) Influence of ambient temperature on the course of experimental trypanosomiasis in mice. Ann. Trop. Med. Parasit. 66 15.

91. OXENDER W.D.; NEWMAN L.E.; and MORROW D.A.: (1973) Factors influencing dairy calf mortality in Michigan J. Am. Vet. Med. Ass. 162 458.

92. BANDIAN M.R.; and TALWAR G.P.: (1971) Effect of growth hormone on the metabolism of thymus and on the immune response against sheep erythrocytes. J. Exp. Med. 134 1095.

93. PARMELY M.J.; BEER A.E.: (1977) Colostral cell mediated immunity and the concept of a common secretory immun. system J. Dairy Sc. 60 655.

94. PENHALE W.J.; CHRISTIE G.: (1969) Quantitative studies on bovine immunoglobulins. Res. Vet. Sc. 10 493.

95. PENHALE W.J.; CHRISTIE G.; McEWAN A.: FISHER E.; and SELMAN I.: (1970) Quantitative studies on bovine immunoglobulins. Brit. Vet. J. 126 30.

96. PENHALE W.J.; LOGAN E.F.; SELMAN I.E.; FISHER E.W.; and MCEWAN A.D.: (1973) Observations on the absorption of colostral immunoglobulins by the neonatal calf and their significant in colibacillosis. Ann. Rech. Vet. 4 223.

97. POLIS B.D.; and SHMUKLER H.W.: (1953) Crystalline lactoperoxidase. J. Biol. Chem. 201 475.

98. PORTER P.; NOAKES D.I.; and ALLEN W.D.: (1972) Intestinal secretion of immunoglobulins in the preruminant calf. Immunology 23 299.

99. PORTER P.: (1972) Quantitative changes in early lactation and absorption by the neonatal calf. Imm. 23 225.

100. REITER B.; ORAM J.D.: (1967) Bacterial inhibitors in milk and other biological fluids. Nature 216 328.

101. RIBER B.: (1978) Antimicrobial system in milk. J. Dairy Res. 45 131.

102. REITER B.: (1978) Non-specific antimicrobial factors. Ann. Rech. Vet. 9 205.

103. ROWLEY M.J.; and MACKAY I.R.: (1969) Measurement of antibody producing capacity in man. Cli. Exp. Immun. 5 407.

104. ROY J.H.B.: (1956) Studies in calf intestine with special reference to the protective action of colostrum. Ph.D. Thesis University of Reading. G.B.

105. SASAKI, M.; DAVIS C.L.; and LARSON B.L.: (1976) Production and turnover of IgG1 and IgG2 immunoglobulins in the bovine around parturiton. J. Dairy Sc. 59 2046.

106. SASAKI M.; LARSON B.L.; and NELSON D.R.: (1977) Kinetic analysis of the binding of immunoglobulins IgG1 and IgG2 to bovine mammary cells. Bioch. Bioph. Acta 497 160.

107. SAWYER M.C.; WILLADSEN H.; OSBURN B.I.; and McGUIRE T. C.: (1977) Passive transfer of colostral immunoglobulins from ewe to lamb and its influence on neonatal lamb mortality. J. Am. Vet. Med. Asso. 171 1255.

108. SAWYER M.; WILLADSEN C.H.; OSBURN B.I.; McGUIRE T.C.: (1977) Passive transfer of colostral immunoglobulins for ewe to lamb and its influence on neonatal lamb mortality J.A.V.M.A. 1255.171

109. SCHULTZ R.D.: (1973) Discussion of the immune response of the fetus and neonate. J.Am. Vet. Ass. 163 507.

110. SELMAN I.E.: (1971) Serum immunoglobulin concentrations of newborn dairy heifer calves. Vet. Rec. 88 460.

111. SELMAN I.E.; McEWAN A.D.; FISHER E.W.: (1971) Studies on dairy calves allowed to suckle their dams fixed times postpartum. Res. Vet. Sci. 12 1.

112. SELMAN I.E.: The absorption of colostral globulins by newborn calves. Ann. Rech. Vet. 4 213.

113. SMITH C.W. and GOLDMAN A.S.: (1968) The cells of human colostrum. Pedi. Res. 2 103.

114. SOLOMON J.B.: (1971) Frontiers of biology series. Fetal and neonatal immunology Vol. 20 North Holland American Elsevier Amsterdam and New York.

115. STALEY T.E.; CORLEY L.D.; BUSH L.J.; and JONES E.W.: (1972) The ultrastructure of neonatal calf intestine and absorption of heterologous proteins. Anat. Rec. 172 559.

116. STERZL J.; and SILVERSTEIN A.: (1967) Developmental aspect of immunity. Adv. in Immun. 6 337.

117. STOTT G.H.; WIERSMA F.; MENEFEE B.E.; and RADWANSKI R.R.: (1976) Influence of environment on passive immunity in calves. J. Dairy Sc. 59 1306.

118. STOTT G.H.; and MENEFEE B.E.: (1978) Selective absorption of IgM in the newborn calf. J. Dairy Sci. 61 461.

119. STOTT G.H.; REINHARD E.J.: (1978) Adrenal function and passive immunity in the dystocial calf. J. Dairy Sc. 61 1457.

120. STOTT G.H.; MARX D.B.; MENEFEE B.E.; NIGHTENGALE G.T.: (1979) Colostral immunoglobulin transfer in calves II. Rate of absorption J. Dairy Sc. 62 1766.

121. STOTT G.H.: (1980) Immunoglobulin absorption in calf neonates with special considerations of stress. J. Dairy. Sc. 63 681.

122. TENNANT B.; HARROLD D.; REINA-GUERRA M.; and LABEN R.C.: (1969) Neonatal alterations in serum gamma globulin levels of Jersey and Holstein-Friesian calves. Amer. J. Vet. Res. 30 345.

123. TERRES G.; MORRISSON S.L.; and HABICHT G.S.: (1968) A quantitative difference in the immune response between male and female mice. Proc. Soc. Exp. Biol. Med. 127 664.

124. TIETZ W.S. Jr.: (1977) in DUKE'S Physiology of Domestic Animals 9th Ed. Cornell University Press Ithaca N.Y. 14850.

125. TIZARD IAN R.: (1977) An introduction to veterinary immunology. W. B. Saunders Company.

126. TOP F.H.: (1964) Environment in relation to infectious disease. Arc. envir. Health 9 699.

127. TORMEY D.C.; and MUELLER G.C.: (1972) Biological effects of transferrin in human lymphocytes in vitro. Expl. Cell. Res 74 220.

128. TROMP S.W.: (1963) Medical biometeorology Weather, climate and the living organism. Amsterdam: Elsevier.

129. VESTWEBER J.: (1980) Personnal communication. Depart. Med. Surg. Coll. Vet. Med. Manhattan, Kansas 66506. U.S.A.

130. WARDLAW A.C.: (1962) The complement f-dependent bacteriology activity of normal human serum. J. Exp. Med. 115 123.

131. WARNER R.G.; BROWNSTEIN M.T.: (1976) Factors affecting the immune response in calves and its relationship to subsequent performance. Proceeding 1976. Cornell Nutri. Conference for feed manufacture.

132. WOODRUFF: (1972) Factors affecting the depression of cell-mediated immunity in protein-calorie malnutrition Lancet 1 92.

APPENDIX

The following data are those concerning the preparation and the lecture of the radioimmunodiffusion plates.

No specification means that in the referring plate we used the plate and standard from Miles Laboratory Inc. Elkart, Indiana 46514.

The concentrations are expressed in mg/100 ml.

The diameters are expresses in millimeters.

The missing values are those of trials done for the selection of our standards.

IgG1
Calf serums were diluted 1:10

	1	2	3	4	5	6
Calf number	97	108	104	103	89	99
Diameter	8.2	6.7	8.9	12.8	12.5	7.8
Concentration	122.5	78.0	146.2	314.5	299.4	109.7
Diameter of Sd	12.5	9	6.6	4.8	3.8	
Concent-of Sd	300	150	75	35	17.5	
Calf number	X	G_a 1:16	G_a 1:8	G_a 1:4	G_a 1:2	G_a
Diameter	X	6.7	9.3	13.0	16.6	18.6
Concentration	X	78.0	160.7	324.7	523.0	676.5

G_a: Trial to select K.S.U. laboratory standard for IgG1

	1	2	3	4	5	6
Calf number	74	100	95	96	51	11
Diameter	13.0	3.5	6.6	9.0	8.5	5.6
Concentration	336.1	17.0	80.7	157.0	139.1	51.6
Diameter of Sd	11.5	8.8	6.6	4.6	3.5	
Concent-of Sd	300	150	75	35	17.5	
Calf number	X	G_b1:32	G_b1:16	G_b1:8	G_b 1:4	G_b1:2
Diameter	X	4.8	6.5	9.1	12.7	15.3
Concentration	X	39.0	78.1	160.6	320.0	468.0

G_b: Final serum used as K.S.U. Laboratory standard for IgG1

IgG1

	1	2	3	4	5	6
Calf number	56	62	20	24	102	98
Diameter	6.5	12.0	11.4	6.6	9.2	8.2
Concentration	70.6	245.6	221.5	72.9	143.5	113.6
Diameter of Sd	9.4	6.7	4.6	3.4		
Concent-of Sd	150	75	35	17.5		
Calf number	91	93	109	107	92	78
Diameter	7.4	9.2	5.5	9.6	7.6	8.2
Concentration	92.1	143.5	50.0	156.5	97.3	113.0

	1	2	3	4	5	6
Calf number	85	59	45	19	77	05
Diameter	6.0	11.0	11.0	8.0	5.9	10.6
Concentration	49.5	175.2	175.2	90.9	47.8	162.6
Diameter of Sd	12	10.2	7.3	5	3.8	
Concent-of Sd	300	150	75	35	17.5	
Calf number	47	66	79	58	43	28
Diameter	10.0	10.0	11.0	5.7	8.3	6.2
Concentration	144.1	144.1	175.2	44.3	98.2	53.1

IgG1

	1	2	3	4	5	6
Calf number	50	10	105	61	38	27
Diameter	8.5	6.1	11.5	7.5	10.0	9.2
Concentration	119.5	60.8	220.0	92.7	166.0	140.3
Diameter of Sd	12.4	9.5	6.8	4.6	3.4	
Concent-of Sd	300	150	75	35	17.5	
Calf number	67	94	80	39	88	33
Diameter	10.0	5.6	3.0	12.0	11.0	11.0
Concentration	166.0	51.0	13.5	239.7	201.2	201.2

	1	2	3	4	5	6
Calf number	68	23	46	76	53	57
Diameter	10.6	11.0	8.6	10.0	11.4	11.0
Concentration	190.6	231.6	139.7	190.6	243.2	231.6
Diameter of Sd	11.3	8.9	6.4	4.5	3.4	
Concent-of Sd	300	150	75	35	17.5	
Calf number	40	63	86	55	32	12
Diameter	9.0	6.5	12.0	9.4	7.6	11.2
Concentration	153.4	77.6	276.6	167.8	108.0	240.0

IgG1

*	1	2	3	4	5	6
Calf number	83	73	64	29	22	44
Diameter	7.0	7.1	8.5	8.2	8.5	6.5
Concentration	89.4	92.1	133.8	124.3	133.8	76.5
Diameter of Sd	12.6	9.0	6.6	4.3		
Concent-of Sd	300	150	75	35		
Calf number	90	06	35	75	54	82
Diameter	4.2	6.6	4.3	6.5	8.0	7.5
Concentration	29.5	79.0	31.2	76.5	118.1	103.3

*This plate was prepared in house using rabbit antibovine IgG1 from Miles-Laboratory Inc.

*	1	2	3	4	5	6
Calf number	70	48	14	84	02	52
Diameter	6.0	7.2	10.5	11.8	7.5	7.2
Concentration	34.2	54.8	130.6	168.2	60.5	54.8
Diameter of Sd	11.0	8.6	6.4	4.7		
Concent-of Sd**	160.6	78.0	39.0	19.5		
Calf number	30	34	81	71	26	16
Diameter	8.0	5.5	10.5	10.5	6.5	4.5
Concentration	70.6	26.8	130.6	130.6	42.4	13.8

*This plate was prepared in house using rabbit antibovine IgG1 from Miles-Laboratory, Inc.

** This standard was prepared in house using bovine serum.

IgG1

	1	2	3	4	5	6
Calf number	08	03	04	01	18	69
Diameter	5.5	4.0	3.5	6.4	8.0	7.0
Concentration	105.7	49.0	34.1	148.3	239.9	180.2
Diameter of Sd	8.9	6.4	4.8	3.5		
Concent-of Sd	300	150	75	35		
Calf number	41	37	87	09	13	07
Diameter	5.7	7.6	8.7	7.7	7.7	7.2
Concentration	114.6	215.1	286.4	221.2	221.2	191.5

	1	2	3	4	5	6
Calf number	25	21	42	49	31	36
Diameter	6.2	5.7	5.5	8.9	5.6	7.4
Concentration	148.5	123.0	113.4	323.2	108.7	218.6
Diameter of Sd	8.6	6.2	4.6	3.5		
Concent-of Sd	300	150	75	35		
Calf number	72	34	23	16	05	19
Diameter	7.4	3.2	7.8	3.1	6.6	5.1
Concentration	218.4	27.7	244.5	24.9	170.4	95.2

IgA

	1	2	3	4	5	6
Calf number	50	10	105	61	38	27
Diameter	6.7	7.2	6.7	6.5	9.5	7.7
Concentration	66.9	81.1	66.9	61.5	159.5	96.3
Diameter of Sd	12.5	10.5	7.8	6.0	5.0	
Concent-of Sd	400	200	100	50	25	
Calf number	67	94	80	39	88	33
Diameter	7.3	5.2	0	11.5	7.4	8.7
Concentration	84.0	30.4	0	245.3	87.0	129.8

	1	2	3	4	5	6
Calf number	68	23	46	76	53	57
Diameter	10.8	12.0	7.5	11.2	8.5	9.5
Concentration	213.5	269.7	89.4	231.7	122.3	159.3
Diameter of Sd	10.5	7.8	6.1	5.0		
Concent-of Sd	200	100	50	25		
Calf number	A	A1:2	A1:4	A1:8	A1:16	
Diameter	100 large	10.5	8	6	5.1	X
Concentration	?	200.4	105.4	47.8	27.3	X

A = Trial to select K.S.U. Laboratory standard for IgA

IgA

	1	2	3	4	5	6
Calf number	97	99	89	104	108	103
Diameter	4.3	7.0	8.0	8.6	4.5	7.9
Concentration	6.9	77.3	111.8	134.8	11.01	87.2
Diameter of Sd	10.1	7.7	6.1	5.1		
Concent-of Sd	200	100	50	25		
Calf number	A_o	A_o1:2	A_o1:4	A_o1:8	A_o1:16	X
Diameter	O	O	O	O	O	X
Concentration	O	O	O	O	O	X

A_o = Trial to select K.S.U. Laboratory standard for IgA

	1	2	3	4	5	6
Calf number	74	100	95	96	51	11
Diameter	11.5	O	8.5	8.5	10.6	6
Concentration	220.9	O	109.5	109.5	183.2	42.6
Diameter of Sd	11.0	8.2	6.3	5.2		
Concent-of Sd	200	100	50	25		
Calf number	A_o	A_o1:2	A_o1:4	A_o1:8	A_o1:16	X
Diameter	2.0	1.0	O	O	O	X
Concentration	O	O	O	O	O	X

A_o = Trial to select K.S.U. Laboratory standard for IgA

IgA

	1	2	3	4	5	6
Calf number	40	63	86	55	32	12
Diameter	9.4	4.5	11.5	10.0	7.5	7.5
Concentration	185.6	10.8	314.9	227.3	108.6	108.6
Diameter of Sd	12.3	9.5	7.2	6.0	5.0	
Concent-of Sd	400	200	100	50	25	
Calf number	A_2	$A_2$1:2	$A_2$1:4	$A_2$1:8	$A_2$1:16	76
Diameter	11.0	10.3	8.0	6.3	5.2	9.9
Concentration	284.3	243.9	129.6	63.6	29.3	226.4

A_2 = Final serum used as K.S.U. Laboratory standard for IgA

*	1	2	3	4	5	6
Calf number	83	73	64	29	22	44
Diameter	6.5	6.4	8.0	5.5	10.0	8.1
Concentration	47.7	45.2	88.8	25.0	156.9	91.9
Diameter of Sd	12.0	9.5	7.0	5.6		
Concent-of Sd**	243.9	129.6	63.6	29.3		
Calf number	90	06	35	75	82	54
Diameter	O	10.5	5.5	11.5	10.0	10.2
Concentration	O	176.9	25.0	217.9	156.9	164.6

* This plate was prepared in house using rabbit anti-bovine IgA from Miles Laboratory Inc., Elhart, Indiana 46514

** This standard was prepared in house using concentrated bovine nasal secretion.

IgA

*	1	2	3	4	5	6
Calf number	70	48	14	84	02	52
Diameter	6.2	6.0	11.0	6.5	5.8	6.6
Concentration	48.4	44.3	186.4	54.7	40.3	56.9
Diameter of Sd	12.5	9.2	7.0	5.2		
Concent-of Sd**	243.9	129.6	63.6	29.3		
Calf number	30	34	81	71	26	16
Diameter	6.6	O	12.0	7.2	5.7	O
Concentration	5.0	O	224.8	70.8	38.4	O

* This plate was prepared in house using rabbit anti-bovine IgA from Miles Laboratory, Inc.

** This standard was prepared in house using concentrated bovine nasal secretion.

*	1	2	3	4	5	6
Calf number	08	03	04	01	18	69
Diameter	7.0	4.3	4.0	6.3	6.4	14
Concentration	76.8	11.9	6.6	57.0	59.7	389.0
Diameter of Sd**	11.3	8.6	6.5	5.2		
Concent-of Sd	243.9	129.6	63.6	29.3		
Calf number	41	37	87	9	13	07
Diameter	6.0	11.0	10.0	7.0	9.8	8.2
Concentration	49.1	229.7	185.1	76.8	176.7	115.5

* This plate was prepared in house using rabbit anti-bovine IgA from Miles Laboratory, Inc.

** This standard was prepared in house using concentrated bovine nasal secretion.

IgA

	1	2	3	4	5	6
Calf number	56	62	20	24	102	98
Diameter	8.9	12.3	7.8	7.5	8.5	6.0
Concentration	143.2	309.5	101.5	90.9	127.7	44.3
Diameter of Sd	12.3	10.2	7.7	6.2	5.3	
Concent-of Sd	400	200	100	50	25	
Diameter	8.0	8.7	0	5.5	9.4	7.1
Concentration	108.7	139.6	0	31.1	164.8	77.5

	1	2	3	4	5	6
Calf number	85	59	45	19	77	05
Diameter	6.5	8.7	10.5	6.5	6.2	10.8
Concentration	61.7	138.8	218.5	61.7	52.9	233.2
Diameter of Sd	10.1	7.7	6.1	5.1	11.5	
Concent-of Sd	200	100	50	25	400	
Calf number	47	66	79	58	43	28
Diameter	11.0	7.8	9.0	5.0	7.0	5.3
Concentration	243.3	104.6	151.0	21.9	77.3	29.0

IgA

*	1	2	3	4	5	6
Calf number	25	21	42	49	31	36
Diameter	6.5	6.2	5.8	7.7	6.5	5.7
Concentration	66.9	57.0	44.5	111.3	66.9	41.5
Diameter of Sd	10.5	8.1	6.5	5.2		
Concent-of Sd**	243.9	129.6	63.6	29.3		
Calf number	72	34	23	16	05	19
Diameter	10.0	O	10.9	O	10.2	6.4
Concentration	217.4	O	266.4	O	227.4	63.6

* This plate was prepared in house using rabbit anti-bovine IgA from Miles Laboratory, Inc.

** This standard was prepared in house using concentrated bovine nasal secretion.

IgM

*	1	2	3	4	5	6
Calf number	54	82	75	86	71	30
Diameter	9.0	8.0	7.5	10.0	7.6	5.8
Concentration	298.0	203.0	161.0	404.2	169.1	28.7
Diameter of Sd	8.6	7.1	6.2	11	6.0	48.2
Concent-of Sd	260	130	60	520	02	
Calf number	47	07	13	09	87	37
Diameter	8.0	8.2	8.7	8.7	9.0	8.0
Concentration	203.0	222.0	269.0	269.0	298.0	203.0

IgM

	1	2	3	4	5	6
Calf number	97	99	89	104	103	108
Diameter	4.4	8.2	9.5	7.6	9.8	5.3
Concentration	10.9	126.5	181.0	104.0	194.8	33.6
Diameter of Sd	12.2	8.3	6.2	5.2	4.5	
Concent-of Sd	320	130	60	30	15	
Calf number	O	$M_1$1:16	$M_1$1:8	$M_1$1:4	$M_1$1:2	M_1
Diameter	O	5	6.4	7.2	9.5	11.6
Concentration	O	26.3	64.2	90	181	308

M_1 = Trial to select K.S.U. Laboratory standard for IgM

	1	2	3	4	5	6
Calf number	74	100	95	96	81	11
Diameter	8.9	4.2	8.0	9.0	10.4	6.4
Concentration	163.0	13.7	126.1	167.3	233.2	70.2
Diameter of Sd	12.0	8.1	6.0	5.0		
Concent-of Sd	320	130	60	30		
Calf number	M_2	$M_2$1:2	$M_2$1:4	$M_2$1:8	$M_2$1:16	14
Diameter	11.5	9.4	7.6	6.1	5.3	8.3
Concentration	291.6	185.2	111.0	61.1	39.0	138.0

M_2 = Final serum used as K.S.U. Laboratory standard for IgM

IgM

	1	2	3	4	5	6
Calf number	56	62	20	24	102	98
Diameter	7.8	10.0	9.5	8.0	8.8	6.2
Concentration	98.6	185.2	163.7	105.6	135.3	49.1
Diameter of Sd	12.7	8.6	6.6	5.5	9.8	176.5
Concent-of Sd	320	130	60	30	70	
Calf number	91	93	109	107	92	78
Diameter	7.2	10.2	4.6	10.0	7.8	7.6
Concentration	78.7	194.1	10.9	185.2	105.6	91.8

	1	2	3	4	5	6
Calf number	85	59	45	19	77	05
Diameter	6.0	9.3	6.6	6.5	6.3	10.2
Concentration	54.7	170.8	72.1	69.1	63.2	211.1
Diameter of Sd	12.3	8.3	6.2	5	9	158.2
Concent-of Sd	320	130	60	30	52	
Calf number	47	66	79	58	43	28
Diameter	10.5	8.0	7.7	5.4	6.6	5.7
Concentration	225.4	119.1	108.2	39.0	72.1	46.6

IgM

	1	2	3	4	5	6
Calf number	50	10	105	61	38	27
Diameter	9.2	6.5	9.2	6.0	9.0	8.6
Concentration	161.1	72.3	161.1	54.2	146.3	128.1
Diameter of Sd	9.8	7.8	6.1	5.1	8.6	138.7
Concent-of Sd**	185.2	111	61.1	39	48	
Calf number	67	94	80	39	88	33
Diameter	8.5	5.7	4.0	10.0	9.0	9.5
Concentration	135.1	51.8	17.8	180.8	138.7	153.4

	1	2	3	4	5	6
Calf number	68	23	46	76	53	57
Diameter	9.0	11.5	8.1	9.6	10.0	9.0
Concentration	163.8	284.0	127.7	190.1	208.4	163.8
Diameter of Sd*	9.5	7.6	6.2	5.2	4.2	15.2
Concent-of Sd**	185.2	111.0	61.1	39.0	34	
Calf number	40	63	86	55	32	12
Diameter	9.3	5.0	10.2	7.0	7.0	8.2
Concentration	176.7	39.5	217.8	88.8	88.8	131.5

* This plate was prepared in house using rabbit anti-bovine IgM from Miles Laboratory, Inc.

** This standard was prepared in house using bovine serum.

IgM

	1	2	3	4	5	6
Calf number	25	21	42	49	31	36
Diameter	7.0	5.5	6.7	9.2	6.8	6.5
Concentration	100.0	36.4	81.1	221.3	90.7	77.2
Diameter of Sd	9.8	7.6	6.1	10.5	308.3	
Concent-of Sd	260	130	60	44		
Calf number	72	23	16	90	35	6
Diameter	8.7	10.5	O	4.7	5.9	6.8
Concentration	190.8	308.3	O	8.7	52.0	90.7

	1	2	3	4	5	6
Calf number	22	29	64	73	83	26
Diameter	8	7.2	7.5	7.0	6.8	7.3
Concentration	159.0	115.6	131.3	105.4	95.6	120
Diameter of Sd	9.6	7.5	6	7.1	110.6	2.9
Concent-of Sd	260	130	60	08	04	4.5
Calf number	69	41	01	18	03	51
Diameter	8.2	6.3	5.5	9.0	4.5	8.2
Concentration	170.6	72.3	38.6	219.6	2.9	170.6

IgG2
Calf serums were diluted 1:3 except for plates as indicated

	1	2	3	4	5	6
Calf number	97	108	104	89	99	103
Diameter	3.5	4.0	3.7	5.0	4.0	6.0
Concentration	27.2	33.8	29.7	49.8	33.8	69.3
Diameter of Sd	11.0	7.7	5.2	3.4		
Concent-of Sd	220	110	55	25		
Calf number	G_{2a}1:16	G_{2a}1:8	G_{2a}1:4	G_{2a}1:2	G_{2a}	
Diameter	6.6	9.8	11.8	15.0	18.0	
Concentration	82.7	175.7	252.3	405	579	

G_{2a} = Trial to select K.S.U. Laboratory standard for IgG2

	1	2	3	4	5	6
Calf number	74	100	95	96	51	11
Diameter	5.5	O	4.1	4.0	4.0	3.6
Concentration	60	O	35.2	34.9	34.9	29.6
Diameter of Sd	11.0	7.7	5.2	3.2		
Concent-of Sd	22.0	110	55	25		
Calf number	G_{2b}1:64	G_{2b}1:32	G_{2b}1:16	G_{2b}1:8	G_{2b}1:4	X
Diameter	3.4	4.3	5.8	8.6	11.8	X
Concentration	27.1	39.0	66.0	136.9	251.6	X

G_{2b} = Final serum used as K.S.U. Laboratory standard for IgG2

IgG2

	1	2	3	4	5	6
Calf number	56	61	20	24	102	91
Diameter	4.5	8.0	4.0	3.5	4.6	3.5
Concentration	44.2	125.5	36.2	29.3	45.8	29.3
Diameter of Sd	10.7	7.5	5.1	3.1		
Concent-of Sd	220	110	55	25		
Calf number	93	109	107	92	98	78
Diameter	4.8	O	5.5	3.5	3.6	3.0
Concentration	49.3	O	62.8	29.3	30.6	23.2

	1	2	3	4	5	6
Calf number	85	59	45	19	77	05
Diameter	3.2	4.0	4.0	3.0	3.0	4.0
Concentration	25.5	36.5	36.5	23.2	23.2	36.5
Diameter of Sd	10.6	7.4	5.1	3.1		
Concent-of Sd	220	110	55	25		
Calf number	47	66	79	58	43	28
Diameter	4.5	4.2	4.0	3.0	3.2	3.0
Concentration	44.6	39.6	36.5	23.2	25.5	23.2

IgG2

	1	2	3	4	5	6
Calf number	83	73	64	29	22	44
Diameter	5.8	4.5	7.2	8.0	8.6	6.5
Concentration	24	11.2	41.0	52.0	61.5	32.0
Diameter of Sd	15.6	11.2	8.3	5.8	5.8	24.0
Concent-of Sd	220	110	55	25	2	
Calf number	90	06	35	75	52	30
Diameter	O	6.2	3.8	7.6	5.5	5.5
Concentration	O	28.2	6.0	46.3	21.0	21.0

	1	2	3	4	5	6
Calf number	71	26	16	82	54	70
Diameter	8.0	5.0	O	6.0	11.0	6.0
Concentration	52.0	17.6	O	26.0	105.5	26.0
Diameter of Sd	15.6	11.2	8.3	5.8		
Concent-of Sd	220	110	55	25		
Calf number	48	14	84	81	X	X
Diameter	4.5	10.0	5.0	8.0	X	X
Concentration	11.2	86.0	16.0	52.0	X	X

IgG2

In this plate the calf serums were diluted 1:2 instead of 1:3

	1	2	3	4	5	6
Calf number	50	10	105	61	38	27
Diameter	5.5	4.0	4.5	5.0	6.0	4.8
Concentration	63.6	36.5	44.6	53.6	74.5	49.9
Diameter of Sd	10.6	7.4	5.1	3.1		
Concent-of Sd	220	110	55	25		
Calf number	94	80	39	88	33	67
Diameter	4.0	O	4.5	7.0	6.8	6.1
Concentration	36.5	O	44.6	99.2	94.0	76.8

In this plate the calf serums were diluted 1:2 instead of 1:3

	1	2	3	4	5	6
Calf number	68	23	46	76	53	57
Diameter	9.0	9.4	O	8.5	8.0	12.5
Concentration	47.3	53.4	O	40.0	33.2	109.7
Diameter of Sd	12.5	9.5	7.5	6.2		
Concent-of Sd	110	55	25	12.5		
Calf number	40	63	86	55	32	12
Diameter	6.5	6.0	9.6	O	10.0	O
Concentration	15.1	9.9	56.5	O	63.0	O

IgG2

	1	2	3	4	5	6
Calf number	08	03	04	01	18	69
Diameter	7.5	0	0	7.5	7.0	3.5
Concentration	23.2	0	0	23.1	17.4	0
Diameter of Sd	12.8	9.8	7.7	6.5		
Concent-of Sd	110	55	25	12.5		
Calf number	41	37	87	09	13	07
Diameter	0	7.0	0	9.0	9.2	6.5
Concentration	0	17.6	0	42.8	45.7	12.0

	1	2	3	4	5	6
Calf number	25	21	42	49	31	36
Diameter	7.5	7.3	6.0	0.0	6.8	6.8
Concentration	24.9	22.3	7.2	0	16.2	16.2
Diameter of Sd	12.4	9.5	7.6	6.4		
Concent-of Sd	110	55	25	12.5		
Calf number	72	34	23	16	05	19
Diameter	10.0	0	9.5	0	8.2	7.2
Concentration	63.1	0	54.6	0	34.5	21.1

EFFECT OF PRENATAL ENERGY INTAKE, MONENSIN AND HEMOPHILUS SOMNUS VACCINATION ON SERUM IMMUNOGLOBULIN VALUES OF SUCKLING BEEF CALVES

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ABSTRACT

The passive lactoglobulin transfer from beef cows to their suckled offsprings is dependent on numerous factors.

This study was designed to estimate the effect of certain factors such as: (1) the energy levels of prepartum diets, (2) the addition of Monensin to the rations, (3) the vaccination of dam against Hemophilus somnus, (4) the effect of the wind-chill and total solar radiation, (5) the calf and dam weights at parturition, (6) the breed of the dam, (7) the difficulty of birth and (8) delay in standing and nursing after birth.

Comparisons were also made between the 48 hours serum immunoglobulin values and the diseases contracted at 3 to 4 months of age.

The concentration of gamma globulin IgG1, IgG2, IgM and IgA were measured using the radial immunodiffusion technique on sera from 103 suckled or bottle-fed 48 hour-old calves.

No significant difference was found in the immunoglobulin transfer from cows on low and high energy prepartum diets.

The addition of Monensin to either low or high energy prepartum rations did not significantly affect the immunoglobulin transfer in all immunoglobulin classes except for IgA, where the mean values were significantly lower in calves whose dams were on high energy prepartum diet with Monensin.

A significant decrease in the efficiency of immunoglobulin transfer was noted in calves whose dams were on the

high energy ration with Monensin compared with calves which dams had received the low energy prepartum diet with Monensin. A more significant decrease was noted for IgG1, IgA and total Immunoglobulin concentrations in calves whose dams had received the high energy diet with Monensin when compared with calves whose dams were on the low energy ration without Monensin.

The cows' weight at parturition had a significant effect on the IgG2 and IgM values of the calves with lower mean concentrations associated with cows of lighter body weights.

Significant lower values for IgG1 and total Ig were noted in calves which dams had the highest body-condition scores.

Significantly higher serum immunoglobulin concentrations in all immunoglobulin classes were found in calves which mothers were of Angus breed or Angus X Hereford than in calves which dams were pure Hereford.

The vaccination of dams against Haemophilus somnus during the prepartum period significantly increased the serum concentration in IgG1 of their offsprings. A negative correlation was noted between IgG1, IgM and total immunoglobulin and the calf weights at birth.

No significant difference of serum immunoglobulin values was noted between male and female calves.

A negative correlation was noted between the increased difficulty of calving and the immunoglobulin transfer. A

delay in nursing and standing did not show any significant effect on the 48 hours calf serum concentrations.

A negative correlation was noted between the wind-chill values during the first 48 hours post partum and the IgG1 and IgA but not for IgM nor IgG2 serum concentrations.

The wind-chill during the last 3 weeks preceding parturition did not significantly affect the immunoglobulin transfer except for Ig and IgM for the third week and for IgG2 for the week preceding parturition.

A positive correlation was noted between the total solar radiation during the first 48 hours and the immunoglobulin transfer. No significant effect was noted for the other periods.

No significant relationship was found between the incidence and severity of pneumonia in the 3 to 4 months old calves and their respective immunoglobulin concentrations at 48 hours of age.

Data subjected to different statistical analyses showed that the immunoglobulin classes were not affected to the same degree by the various factors studied in this experiment. The study further showed that the effect of each factor was not sufficient to explain by itself the lack of immunoglobulin transfer. It appears that a combination of several negative factors occurring simultaneously produce the lack of efficient immunoglobulin transfer in the normal suckled beef calf.