WORKING TOWARDS HEALTHIER, MORE PRODUCTIVE LIVESTOCK

A. Fertig

Adapting to Heat Stress

Cattle in the Southwest are exposed to a variety of environmental stresses including extreme heat. The overall interaction between the genetic makeup of the animal and the environment determines the ability to be productive and efficient. These factors can limit the overall productivity of animals and are therefore important considerations for successful management. Research in this lab focused on the interaction between specific genes in cattle and the environment to provide new insights into how an animal adapts to heat stress. The approach taken has centered on research at the cell and subcellular level and the use of recombinant DNA technology.

If cultured cells are exposed to temperatures a few degrees above normal, a specific set of genes is activated that produces high levels of a new set of proteins called heat shock proteins. This response has been observed in a variety of cells from different organism and is therefore universal. These heat shock proteins are thought to have a protective role in aiding the cell to survive heat stress as well as a variety of other stresses.

Our lab has demonstrated the presence of eight different heat shock proteins in heat stressed cells isolated from cattle. Preliminary results have also demonstrated that the synthesis of the two major heat shock proteins increases during the summer when these animals are exposed to extreme temperatures. Detailed identification and characterization of these proteins is necessary to better understand their function and importance during heat stress in cattle. Further studies on identifying where in the cell these proteins are located and what other factors regulate their levels are also needed to understand how they protect a cell from heat stress.

Isolation of the genes for these proteins in cattle will provide information on how the amounts of heat shock proteins are regulated in the cell. The characterization of this set of genes will make it possible to compare the regulation of these proteins in animals that experience heat stress as well as comparisons among various breeds of cattle. This research will determine if heat shock proteins are important in helping cattle cope with heat stress and if this can be used to produce animals better suited to the hot climate of the Southwest.

Dr. Vince Guerriero
Animal Sciences

More Efficient Meat Production

It's no secret that it's more costly to produce a pound of meat protein than a pound of plant protein, but it's also no secret that the nutritional quality of meat protein is greater than the quality of most plant proteins. Furthermore, it's doubtful that tofu consumption will exceed chicken, pork or beef consumption in Arizona in the near future. Therefore, the challenge is to improve the efficiency of meat protein production.

Manipulation of normal muscle growth processes represents an area where major progress may be expected. Two important biological developments make this approach feasible. With the advent of the "biotechnology age" the economical production of naturally occurring protein growth regulators has become a reality. The second development has been less dramatic and is currently lagging behind the first; this is the development of detailed understanding of cellular and molecular mechanisms responsible for muscle development and growth. Without first knowing the identity and actions of naturally occurring muscle growth regulators, the biotechnology sector will not know which protein regulatory factors to produce.

Scientists in the Animal Sciences Department have been studying the development of muscle fibers and the factors that regulate these events. Muscle fibers are formed during prenatal life from precursor cells called myoblasts. These cells divide many times, and then they fuse together to form long cylindrical cells that become muscle fibers. A similar process occurs in postnatal muscle when myoblast-like cells divide and fuse with the existing fibers to increase the fiber's capacity to make protein and grow. These events determine the ultimate size of the muscle or the amount of meat that can be produced.

In the developing fetus and in growing animals certain hormones or growth factors tell myoblasts when to divide, when to stop dividing and when to fuse together to form a fiber. Research conducted in UA laboratories has identified two classes of proteins that stimulate postnatal myoblast division. Hormones called somatomedins are one group. These hormones are normally found circulating in the blood and tend to be found in higher quantities in rapidly growing animals and people. The second class of proteins is referred to as fibroblast growth factors. These small proteins probably do not circulate in the blood stream but may be synthesized and secreted in the muscle tissue itself where they may stimulate the division of myoblast-like cells. Recent experiments suggest that these two kinds of factors, somatomedins and fibroblast growth factors, must work together to stimulate myoblasts. The manner in which these kinds of protein hormones and growth factors interact with muscle myoblasts is currently under investigation.

If these two kinds of proteins can be supplied to growing muscle, the rate of growth and the efficiency of muscle protein production should be increased.

Dr. R.E. Allen
Animal Sciences

Cattle Infection and Infertility

A number of fastidious organisms, chlamydia, ureaplasma and mycoplasma, have been incriminated as causing infertility and abortion in cattle in recent years. A study was initiated to determine the presence and prevalence of these organisms in the reproductive tracts of Arizona range bulls and cows. Chlamydial organisms were present in 39.5 percent and 20.5 percent of the preputial smegma of bulls and cervicovaginal mucus of range cows respectively. *Mycoplasma* sp. were isolated from 44 percent and 11.8 percent and *Ureaplasma* sp. from 23 percent and 10.8 percent of the same materials from the bulls and cows respectively. The animals were randomly selected from ranches representing the major range cattle populations of the state and were clinically normal.

In the investigation of an infertility and/or abortion problem in a beef herd, the isolation of one of these organisms from the reproductive tract of the cow would not be significant unless there was corroborating lesions since a percentage of normal range cows have these organisms in their reproductive tract. These organisms however, are potentially, a part of the reproductive disease problem of range cattle in Arizona. We are continuing our studies of reproductive disease in Arizona cattle, especially in the areas of infectious disease as it relates to the nutritional status of the range animal.

Dr. E.J. Bicknell
Dr. C. Reggiardo
Veterinary Science

Heat Stress and Embryonic Mortality

Arizona, like many arid and tropical areas of the world, has seasonal high temperatures that are associated with poor reproductive efficiency in dairy cattle. Decreases in fertility that can be directly attributed to heat stress remains one of the most difficult and costly problems of the Arizona dairy industry. Because of the economic importance of reproduction, emphasis has been placed on research in this area.

Previous studies have suggested that infertility in dairy cows during the summer months is associated with a high rate of embryonic death. A study was conducted to determine when embryos were most susceptible to heat stress. Cows were placed in an air-conditioned barn for 5 to 13 days after being bred and conception rates compared to cows maintained in outdoor corrals. Conception rates were approximately 50 percent in air-conditioned and control cows when determined by presence of a pregnancy specific protein 20–25 days after breeding. By day 45, however, 28.6 percent of the air-conditioned cows had viable embryos compared to 16.7 percent of the control cows. Thus, temporary relief from heat stress enhanced embryonic survival but failed to restore it to optimum levels.

Since various lengths of cooling were utilized, it was possible to estimate when embryonic losses were occurring. Approximately 12 percent of the embryonic loss occurred between conception and day 5, while an additional 21 percent of the embryos were lost between day 13 and 30. These two periods appear to be when embryos are most susceptible to heat stress.

The physiological basis for lower embryonic survival during heat stress may center around the anterior pituitary hormone, luteinizing hormone. In recent studies, the secretion of this hormone was found to be suppressed in heat stressed cows. Since this hormone acts to stimulate the development of the corpus luteum, the tissue responsible for recognition and maintenance of pregnancy in the cow, it may prove to be a key in the development of treatments to enhance embryonic survival during heat stress.

Dr. M.E. Wise
Animal Sciences

Serum Immunoglobulin Concentration

Cows are unable to transfer immunity across the placenta prior to birth, and calves are unable to synthesize immunoglobulins at birth. Therefore, it is critical that calves receive colostrum to minimize the probability of life-threatening disease at this critical period of time. The effects of inadequate levels of blood serum immunoglobulins are well documented: increased mortality and morbidity. But the long term effects on calf growth and production are just now being elucidated.

Blood from 1,000 dairy heifers was collected at birth from a large commercial dairy in Arizona. Total serum immunoglobulins were measured for each calf and the calves were weighed and monitored through their first lactation. Calves with less immunoglobulin concentration at birth weighed less at every age through 180 days. At the end of six months, calves that differed by 15 immunoglobulin units (mg/ml) at birth also differed by 82 pounds.

When these heifers had completed their first lactation, the relationships between passive immunization at birth and milk production were evaluated. The regression of mature equivalent milk and fat produced per lactation on immunoglobulin concentration at birth were 17 and 0.5 pounds per unit immunoglobulins. Cows that differed by 15 serum immunoglobulin units at birth would be expected to differ by 256 pounds of milk per lactation and eight pounds of fat. This 1 to 2 percent increase in cow production can have a considerable effect on herd efficiency especially in the large dairies of the Southwest.

By ensuring that all calves receive appropriate quantities and quality of colostrum as soon after birth as possible, dairymen can help maximize production from their herd. Colostral intake can have effects far beyond the immediate problem of calf survival. Adequate serum immunoglobulins shortly after birth can improve the growth rate of dairy heifers, and help them reach breeding weight earlier. It can also have small effects on individual cow production that add up to major effects on herd productivity.

Dr. S.K. DeNise
Animal Sciences

Calf Nutrition and Infection

Confinement, overcrowding and continuous introduction of animals in intensive livestock production systems favor the production and spread of infectious diseases. These diseases are often a major profit-limiting factor in calf-rearing operations in the dairy industry and in some sectors of the beef industry. Not only intensive production conditions favor multiple infections working synergistically, but even minor management or nutritional deficiencies can greatly intensify the impact of these infections on calf health. These complex interactions between infectious agents, environment and nutrition complicate the diagnosis, prevention and treatment of these diseases.

Chlamydial infections of young dairy calves in the first few weeks of life are a prime example of this type of problem. They are one of the most common causes of disease in calves in Arizona. They produce a febrile, systemic disease with respiratory and enteric signs very difficult to differentiate clinically from other diseases of the calf. They usually associate with, and can aggravate, other common infections of the young calf further complicaing their identification in the field. Adverse weather conditions, stress or nutritional deficiencies can precipitate or increase the severity of calf chlamydiosis and secondary infections. Vitamin E deficiency appears to be of particular significance in the production of clinical chlamydiosis. Low or non-detectable plasma vitamin E levels in chlamydia-infected calves has been our repeated observation at the Veterinary Diagnostic Laboratory, recently confirmed in a large field trial in a commercial dairy.

In the trial, the average vitamin level in infected but clinically normal calves was only one-third to one half of that of normal, uninfected calves. The average vitamin level in sick, infected calves was even lower, one fifth to one seventh of that in normal, non-infected pen mates. More important, supplementation of the milk replacer with vitamin E has resulted in normal vitamin levels in the calves and a decrease in the generalized, febrile disease associated with chlamydiosis.

This association is an excellent example of the interdependence between infection and nutrition and of the need for broad, comprehensive diagnostic studies in all disease problems of modern animal industry. Classical recommendations on nutritional parameters may need to be reviewed in light of the demands imposed by disease control programs. The need for additional vitamin E supplementation in confined calves without access to fresh green forage appears evident in this and similar studies. And a growing body of field observations point to possibly similar reevaluation of the needs of the young for vitamin A and minerals such as copper or selenium in the fight against disease.

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