

Summary Reports on Other Projects

The Eating Quality of Beef as Influenced by Age and Muscle Difference

R. L. Hendrickson

Procedures and Results

Three bovine muscles, biceps femoris, sartorius and vastus intermedius were studied. Each of the three muscles vary in size, shape, structure, action, and tenderness. The sartorius muscles showed the least number of nuclei per 100 micron of fiber length. They ranged from 1.5 to 6.9 micron per 100 micron of fiber length with a mean of 4.1. Fibers of greater diameter generally showed more nuclei. The biceps femoris averaged 11.2 micron in length and 5.0 micron in diameter. Vastus intermedius muscle is small but the fibers are large and possessed 14.6 nuclei per 100 micron of length. These fiber nuclei averaged 10.2 micron long and 5.7 micron in diameter for shear fiber. The significance of nuclei number, size, and function in muscle development and quality remains obscure.

Shear force was measured using a newly developed microsensitive shear. A direct relationship was evident between fiber diameter and shear strength. As the diameter increased, the shear force increased. Fifty micron diameter fibers required a shear force of 7.08×10^8 g, while those 70 micron in diameter required 9.41×10^8 . Fibers from the biceps femoris consistently required the greater shear force followed by the vastus intermedius and sartorius.

The Influence of Prewaning Plane of Nutrition on Subsequent Performance of Beef Females

Robert Totusek

Procedures and Results

Low, medium and high levels of preweaning nutrition of Angus and Hereford heifers have been accomplished by (1) weaning at 140 days, (2) weaning at 240 days, and (3) creep feeding to weaning at 240 days, respectively. Large treatment differences in condition and weight (an average of 120 lb. from low to high level heifers) at 240 days of age have largely disappeared by 18 months, although low level heifers have re-

mained 30-40 lb. lighter to 5 years of age. Higher preweaning planes of nutrition have also resulted in larger skeletal size at 240 days, but differences have largely disappeared by 18 months.

Preweaning plane of nutrition has had little affect on conception date and birth weight, but an increasing level of preweaning nutrition has tended to result in a slightly higher percentage calf crop, both calved and weaned. Those females which were weaned at 140 days have produced calves 20 lb. heavier at weaning than those heifers weaned at 240 days or creep fed.

The experiment is being continued through the production of three calf crops. Milk production estimates are also being made.

Selection Procedures for Beef Cattle Improvement

Richard R. Frahm and Joe V. Whiteman

Procedures and Results

The beef cattle selection experiment being conducted at Ft. Reno was designed to measure direct and correlated genetic response to selection for increased body weight at 205 and 365 days of age and to compare responses from selection based on individual performance with selection based on a combination of individual and progeny test performance.

The process of establishing this project is now complete. The two Hereford lines were closed in 1965, two Angus lines were closed in 1967 and the two progeny test Angus lines were closed in 1968. Seventy head of Angus-Holstein crossbred cows were added to the progeny test herd maintained at Stillwater for the purpose of determining if cows with greater potential for producing heavy weaning calves will be more effective for providing progeny test information.

The Influence of Supplemental Winter Feeding on Lifetime Performance of Beef Cows

D. F. Stephens and Robert Totusek

A study designed to determine the influence of supplemental winter feeding on the productivity and longevity of beef cows is nearing completion. One group of 10-year-old cows was removed from the study in 1968. A subsequent final group will wean calves in the fall of 1969.

THIS STUDY HAS INDICATED THAT A moderate winter feed level is optimum for spring calving beef females maintained yearlong on good quality native range, considering both productivity and economics. This moderate level feeding regime permits the weaner heifer to gain approximately 100 lb. her first winter and to lose approximately 10 percent of her fall weight during subsequent winters as a pregnant-lactating female, until she reaches maturity. After maturity is reached, a winter weight loss of 15-20 percent is not detrimental provided adequate summer forage is available. Higher feeding levels have maintained heavier body weights of the female and resulted in earlier calving, higher percent calf crops, and heavier weaning weights, but have resulted in less profit at current feed costs. Lower feeding levels have maintained lighter body weights of the females and resulted in poorer reproductive performance, lower weaning weights, and less profit.

Detailed reports covering twenty years of research will be prepared for publication when the current study is terminated.

Non-Protein Nitrogen Studies With Ruminants

Allen D. Tillman, J. E. McCroskey, R. J. Panciera and E. I. Williams

Procedures and Results

Sodium bentonite was found to absorb the ammonium ion when the concentration of NH_4^+ in the medium was high and release it when the concentration dropped. Growth and metabolism results indicate ration improvement when 2% bentonite was included in high-roughage diets containing high levels of urea. Calcium retention was decreased and that of phosphorus increased by bentonite. A high concentration of ruminal fluid and blood ammonia levels for a short period of time was not detrimental to reproduction in cattle. Acetic acid was found to alleviate urea toxicity symptoms in cattle for about 150 min. and a second dose had to be administered within 165 min. in order to prevent toxicity. A urea supplement was not as efficacious as one containing cottonseed meal when these were fed to pregnant and lactating cows kept on the winter range in Oklahoma. A hemicellulose, in the liquid form, when mixed with cane molasses, was found to furnish carbon fragments for amino acid synthesis by ruminants fed urea as the dietary nitrogen source. The subcutaneous injection of purified jackbean urease into sheep produced antiurease in the blood and fluids. Associated with the accumulation of antiurease was improved growth of sheep, improved feed/gain and lower $\text{NH}_3\text{-N}$ levels in blood and gastrointestinal fluid.

Publications

The following articles have been published from this project during the past year:

- Sidhu, K. S., E. W. Jones and A. D. Tillman. 1968. Effect of urease immunity on growth, digestion and nitrogen metabolism in ruminants animals. *J. Animal Sci.* 27:1703.
- Clifford, A. J., J. R. Bourdette, and A. D. Tillman. 1968. Effect of urease inhibitors on sheep fed diets containing urea. *J. Animal Sci.* 27:1073.
- Clifford, A. J., J. R. Bourdette and A. D. Tillman. 1968. Amino acid supplementation of urea-rich diets for lambs. *J. Animal Sci.* 27:1081.
- Goodrich, R. D., B. P. Bradley and A. D. Tillman. 1968. The importance of initial blood and plasma values. *J. Animal Sci.* 27:247.
- Tillman, A. D. 1969. Urea utilization by ruminants. *Oklahoma Veterinarian*, 21:1.
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Role of Vitamin E and Selenium in Sheep Reproduction

Allen D. Tillman, E. C. Nelson, B. I. Osburn and J. E. Smith

Procedures and Results

Forty-eight ewe and 12 ram lambs were fed a purified diet containing urea as the sole nitrogen source in a 2 by 2 factorial arrangement of treatments. Subcutaneous injections of vit. E (700 I.U. as alpha toco-pheryl acetate) and selenium (5 mg. as sodium selenate) were given separately and in combination once weekly. After 140 days, 24 of the ewes were bred, with treatments being continued until lambing, and then for several additional months. The remaining ewes were bred and sacrificed at various stages of pregnancy to obtain tissues for examinations. Sheep fed the basal purified ration died between the 80th and 230th days of the trials and all had muscular dystrophy. Vitamin E prevented death, while selenium only delayed it. Selenium stimulated growth. Satisfactory reproduction was obtained only in those animals receiving both vitamin E and selenium. Abortions occurred in several ewes on the selenium-deficient diet; however, no pathological changes were found in the reproductive tracts of the ewes, or the rams. None of the fetuses taken from sacrificed ewes had pathological changes. Fertility of rams was not affected by treatment. Vit. E and selenium increased tocopherol level of blood initially but later selenium was ineffective. Vitamin A level in blood was increased by selenium or vitamin E. Blood and tissue enzyme values were determined.

Publications

The following articles have been published from this project during the past year:

- Buchanan-Smith, J. G., B. I. Osburn, J. E. Smith, E. C. Nelson and A. D. Tillman. 1968. Vitamin E and selenium in ewe reproduction. *J. Animal Sci.* 27:1176.
- Buchanan-Smith, J. G., E. C. Nelson and A. D. Tillman. 1969. Tocopherol levels in sheep tissues. *J. Animal Sci.* 28:127.
- Buchanan-Smith, J. G. 1969. Effects of Vitamin E and Selenium Deficiencies in Sheep Fed Purified Diet During Growth and Reproduction. Ph.D. Thesis. Oklahoma State University, Stillwater, Oklahoma.
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Mineral Interrelationship Studies With Ruminants

Allen D. Tillman, T. E. Nelson and L. J. Bush

Procedures and Results

A purpose of this project is to study the importance of the parathyroid glands to calcium homeostasis in ruminants and two trials were conducted to study the effect of age and a calcium-free diet on thyroparathyroidectomized (TPX) sheep. Rate of decline in serum calcium, following TPX in young lambs, was rapid and followed by fatal tetany, even when the animals were fed a normal diet. Positive calcium balances were found in TPX lambs. Adult sheep were more tolerant to TPX, being capable of correcting hypocalcemia and maintaining serum calcium levels above those associated with tetany, even after an extended time on a calcium-free diet. Neither TPX nor feeding a calcium-free diet affected serum magnesium. Two treatments, thyroparathyroidectomy (TPX) and thyroidectomy (TX) were compared to control sheep, which were sham-operated. The TX operation did not influence any of the components measured by the TPX sheep exhibited elevated serum inorganic phosphorus, glutamic-oxalacetic transaminase, creative phosphokinase and isocitric dehydrogenase just prior to death. In other work, lambs were fed the Oklahoma purified diet containing the following calcium: phosphorus ratios: 1:1, 4:1, 7:1, and 10:1. Growth, blood cation levels, blood inorganic phosphorus and balance of dietary cations were response criteria. The data are being analyzed.

Publications

The following articles have been published from this project during the past year:

- Nelson, T. E. and A. D. Tillman. 1967. Calcium status studies in adult sheep. *J. Nutr.* 93:475.

- Nelson, T. E., W. D. Tavernor, E. W. Jones and A. D. Tillman. 1969. Influence of age and calcium-free diet on thyroparathyroidectomized sheep. *J. Nutr.* 97:351.
- Tillman, A. D. 1969. Trace mineral nutrition in cattle. Proceedings Kansas Formula Feed Conference. Kansas State University, Manhattan, Kansas.
- Tillman, A. D. 1969. Mineral nutrition for ruminants. Proceedings Cattle Feeders' Seminar. Oklahoma State University, Stillwater, Oklahoma.
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Mouse Selection Studies

Richard R. Frahm and Irvin T. Omtvedt

Procedures and Results

Currently under construction in the basement of Poultry Industries Building is a mouse genetics laboratory to be utilized in conducting basic research studies in the area of population genetics. Many of the genetic problems facing livestock producers can be at least partially answered more efficiently by utilizing laboratory organisms. In addition to testing population genetics theory, laboratory organisms can be used to conduct pilot studies for obtaining a provisional indication of the possible outcome of similar experiments in other species. Mice are particularly well-suited to use in this capacity since they are mammals with a generation interval of only three months, and large numbers can be economically reared under carefully controlled environmental conditions. Rigid environmental control will be maintained in this laboratory with respect to temperature, humidity and light.

A series of selection lines will be initiated for the purpose of (1) measuring direct and correlated responses to selection for preweaning and postweaning rate of gain in mice, and (2) determining the genetic correlation between preweaning and postweaning rate of gain. This study will consist of 170 litters of mice produced each generation. Three selection lines consisting of 20 litters per line will be selected on the basis of individual rate of gain between three and six weeks of age. An additional 50 litters will be maintained in a random mating control line in order to measure genetic changes that occur in the selection lines. All mice in this study will be individually weighed at three weeks and again at six weeks of age.

The economic importance of growth rate is well recognized by all segments of the livestock industry. Selection of animals at the earliest age possible is a desirable aspect of all breeding programs, but this requires a basic understanding of the genetic relationships between early and late

growth periods. Although the genetic relationship between preweaning and postweaning growth rate is of fundamental importance in livestock improvement programs, it has not been previously established with cattle, sheep or swine because of the necessity of large numbers of experimental animals that must be reared under controlled environmental conditions. The results obtained from this study should reveal the basic genetic relationships that exist and provide a basis of application to other species.

Factors Affecting the Energy Value of Feeds and Energetic Efficiency of Ruminants

J. E. McCroskey

Six sets of identical twin heifers fed a finishing ration are being used in an energy balance study to determine the effects of Melengestrol Acetate (MGA) upon basal heat production and efficiency of energy utilization. Cattle are brought in from the feedlot at intervals and put in open-circuit respiration chambers to determine total energy balance.

Development of Methods for Relating Forage Properties to Intake and Digestibility

J. E. McCroskey

Studies are in progress to compare different levels of polyethylene glycol as an indicator for use in measuring voluntary intake of grazed forage. Data collected during the past year with steers grazing bermudagrass and given indicators to determine forage intake are being analyzed in an attempt to correlate changes in chemical composition of the forage with voluntary intake.

The Effects of Season and Exogenous Hormones on the Reproductive Performance of Swine

C. V. Maxwell, E. J. Turman and J. C. Hillier

Procedures and Results

This project has involved several separate studies with gilts and boars. One study comparing lot-mating and handmating of gilts has been completed and published. The present research with gilts involves the testing of various experimental compounds for possible use in synchronizing estrus. No results are ready for release at this time.

A study has just been completed on the effects of season and three types of shelters, and two methods of cooling on semen quality of boars. This data is now being analyzed and will be published at a later date.

Publications

The following articles have been published from this project during the past year:

Rich, T. D., E. J. Turman and J. C. Hillier. 1968 A comparison of the ovulation rate, fertilization rate and embryo survival of hand-mated and lot-mated gilts. *J. Animal Sci.* 27:443.

The Desirability of Pork Products Processed Prior to Chilling

R. L. Hendrickson, A. F. Parr, E. D. Cagle, F. C. Arganosa,
and Roger Johnson

Procedures and Results

The effect of pre- and post-chill curing on the development and stability of nitroso-pigments in individual pork muscles was investigated. The rate of cure diffusion varied directly with the muscle structure and composition. However, the cure diffused most rapid through the warm muscle. The pre-chilled cured muscles contained significantly ($P < .01$) higher initial concentration of nitroso-pigments than the post-chill cured muscle. This cured pigment was more stable when exposed to 100 ft.c of light for periods up to 24 hours than the post-chill cured muscle.

Tenderness as reflected by the shear force of pre-chill muscle decreased at a rate that closely paralleled the pH decline. This was particularly true beyond four hours after death. Fiber diameter and percent fiber kinkiness exhibited a direct relationship. As one decreased so did the other. Shear value decreased with a decrease in fiber diameter and percent kinkiness.

Longissimus dorsi muscle sliced before the removal of body heat had a significantly higher shear force than corresponding muscle sliced after a 24 hour chill. This difference was due to muscle contraction caused by muscle excision and slicing. Fiber diameter and percent kinkiness were also significantly affected by the slicing temperature. Large fiber diameter and greater kinkiness were found for the cold sliced muscle.

Study of the Calcium and Phosphorous

James A. Coalson, J. C. Hillier, E. C. Nelson, and Charles Maxwell

Procedures and Results

Forty-five pigs were used to study the calcium and phosphorus requirements of baby pigs reared on purified diets from three to nine weeks of age. The pigs were collected in sterile plastic bags and transported to the laboratory under sterile conditions. The fortified and pasteurized cows' milk diet, fed during the first two weeks, contained 1.32 percent calcium and 0.98 percent phosphorus.

During the third week of life, the pigs were gradually changed from the liquid diet to a dry, purified, test diet, on which they remained until they were nine weeks of age. During the test period (three to nine weeks of age) four levels of calcium and phosphorus were fed. Rations A through D contained 0.27, 0.57, 0.95 and 1.25 percent calcium and 0.14, 0.44, 0.73 and 1.05 percent phosphorus, respectively. Body weight and feed intake for each pig were recorded weekly. Blood samples were drawn at the end of the third, sixth and ninth weeks. Four pigs from each treatment group were slaughtered at the conclusion of the trial and various bones and organs were removed for observation and chemical analysis.

Ration A appeared to support normal feed efficiency but the total gain was not comparable to the other rations. Ration A produced normal values for serum calcium, serum inorganic phosphorus, hemoglobin concentrations and hematocrit. The data suggested that pigs on Ration A had the greatest bone resorption rate and pigs on Ration C had the least amount of resorption. Ration C produced the heaviest pigs at nine weeks, the best efficiency, heaviest absolute bone weight, diameter and length, highest percent bone ash and the highest concentrations of calcium and phosphorus in bone ash.

The nasal turbinates were grossly examined for symptoms of atrophic rhinitis but none were positively diagnosed.

On the basis of this study, a level of 0.95 percent calcium and 0.73 percent phosphorus is recommended in complete rations from three to

nine weeks of age when soundest skeletal development is desired. This level of calcium and phosphorus would probably result in increased daily gains and improved feed efficiency, but the added phosphate would increase the cost of the ration.

The data indicated that the higher levels of calcium and phosphorus resulted in greater mineral deposition in the skeleton and presumably a sounder structure. Phosphorus is a rather expensive nutrient, thus, the economics of feeding the higher mineral levels would be of concern to commercial producers interested particularly in feed costs per unit gain to market weights. It would appear that the producer of breeding animals could produce a sounder skeleton by using the higher mineral levels.

Publications

The following articles have been published from this project during the past year.

Coalson, J. A., R. D. Washam, J. C. Hillier, and E. C. Nelson. 1968. A study of the calcium and phosphorus requirements of artificially reared pigs. *J. Animal Sci.* 27:1150, (Abstr.).

Washam, R. D., J. C. Hillier, E. C. Nelson, and J. A. Coalson, 1968. A study of the Ca and P requirements of young pigs. *J. Animal Sci.* 27:1157, (Abstr.).

Washam, R. D., 1968. A study of the calcium and phosphorus requirements of artificially reared young pigs. Thesis for Ph.D. Degree. Oklahoma State University, Stillwater.

Selection for Specific Combining Ability in Swine

I. T. Omtvedt

Procedures and Results

The basic objective of this project is to study the feasibility of selecting purebreds on the basis of their ability to cross. Sow productivity traits generally exhibit considerable hybrid vigor in crossbreeding studies, but unfortunately these traits are lowly heritable and show very little response to direct selection. The hybrid vigor obtained in crossbreeding is "one-shot improvement" and breeders can not expect to obtain increased performance due to additional heterotic response each generation. In this project an effort is made to make continued improvement in two-breed crossbred gilts by selecting the two parent lines on the basis of their crossing ability. The basic procedure is to select the Duroc and Beltsville No. 1 boars and gilts for breeding on the basis of their Duroc-Beltsville crossbred half sisters' productivity (litter size and 21-day weight).

Although the project is only in the fifth generation and it is too early to draw conclusions as to the effectiveness of this mating scheme at the present time, the data collected have been used to answer many questions on other problems confronting the swine industry.

Publications

The following articles have been published from this project during the past year:

- Apple, Kenneth L. 1968. Influence of age of dam and season on productivity and the relationship between productivity of first and second litters in swine. MS Thesis.
- Arganosa, Valentino G. 1968. The influence of genetic factors on pork quality. PhD Thesis.
- Arganosa, V. G., I. T. Omtvedt and L. E. Walters. 1968. Phenotypic and genetic parameters of some carcass traits in swine. *J. Animal Sci.* 27: 283. (abstract)
- Cunningham, P. J. 1969. An investigation of selection indexes in swine populations. PhD Thesis.
- Jesse, Earl F. 1968. Influence of sex and sire-sex interactions on post-weaning performance and carcass traits in swine. MS Thesis.
- Morrisette, M. C. and I. T. Omtvedt. 1969. Influence of an orally active progesterone and diethylstilbestrol on litter size and weights of pigs. *J. Vet. Res.* 29:271.
- Omtvedt, I. T. 1968. Inheritance of some pork quality measurements and their importance in a selection program. *Pork Industry: Problems and Progress*. Iowa State University Press, Ames, Iowa, page 128.
- Omtvedt, I. T., E. L. Jesse and V. G. Arganosa. 1968. Sex and sire-sex interactions in swine. *J. Animal Sci.* 27:285. (abstract)

Influence of High Ambient Temperatures On Reproductive Performance in Swine

I. T. Omtvedt, E. J. Turman, D. F. Stephens and G. W. A. Mahoney

Procedures and Results

In swine operations where producers attempt to farrow a uniform number of pigs during all seasons of the year, seasonal variations become a critical factor. Since reduced reproductive efficiency is most prevalent during summer months, this project was initiated to determine the influence of exposing sows to high ambient temperatures at the time of breeding and at various stages of gestation on their reproductive performance.

Heat stress prior to breeding had no marked influence on performance, but exposing sows to high temperatures the first 15 days after breeding compared to subjecting sows to heat stress 15-30 days post breeding resulted in fewer viable embryos and lower survival rates to 30 days post-breeding. At the present time, emphasis is being placed on possible influences of heat stress during mid and late pregnancy.

Publications

The following articles were published during the past year based on results obtained from this project:

- Edwards, Ronnie, I. T. Omtvedt, E. J. Turman, D. R. Rule, D. F. Stephens and G. W. A. Mahoney. 1968. Influence of high ambient temperatures on sow productivity. Okla. Agr. Exp. Sta. MP-80:97.
- Edwards, R. L., I. T. Omtvedt, E. J. Turman, D. F. Stephens and G. W. A. Mahoney. 1968. Heat stress prior to breeding and in early gestation in gilts. *J. Animal Sci.* 27:300. (abstract)
- Edwards, Ronnie L., I. T. Omtvedt, E. J. Turman, D. F. Stephens and G. W. A. Mahoney. 1968. Reproductive performance of gilts following exposure to heat stress prior to breeding and in early gestation. *J. Animal Sci.* 27:1634.
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