Mouse Selection Studies As An Aid To Animal Breeding Research

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Studies are being conducted with mice to obtain a basic understanding of the genetic interrelationship that exist among growth rate at different stages of the growth curve and with other performance and productivity traits. Knowledge of these genetic relationships will aid in the development of more effective breeding programs to improve the performance level of the livestock species.

A selection study with mice is currently underway to specifically measure direct and correlated response to selection for preweaning and postweaning rate of gain for the purpose of determining the genetic correlation between growth rate at these two intervals in the life cycle. This study consists of 6 selection lines of 20 litters each (3 lines being selected on an intralitter basis for increased 3 weeks weight and 3 lines selected for increased average daily gain from 3 to 6 weeks of age) and a random mating control line of 40 litters that is used to measure genetic changes that occur in the selection lines.

After 6 generations of selection the average 3 week weight of the 3 lines selected for preweaning growth was 10.7 grams which was 1.3 grams (13.8 percent) heavier than the control line, and average daily gain from 3 to 6 weeks of age in the 3 lines selected on the basis of postweaning growth rate was 0.85 gram/day which was 0.15 gram/day (21.4 percent) higher than the control lines. Selection has effectively altered the genetic capabilities of the mice for rapid growth both preweaning and postweaning, respectively. Average daily gain from 3 to 6 weeks of age was essentially the same in the preweaning selection lines as the control line. However, the 3 week weight in the postweaning gain lines was 0.3 gram (3.2 percent) heavier than the control line indicating that selection for increased postweaning growth rate has also resulted in some genetic improvement for preweaning growth rate.

In order to determine if the total weight of a particular muscle system can be altered by selection, another study was initiated in which one line was selected on the basis of the heaviest weight of the hindleg muscle system and a second line was selected on the basis of the lightest hindleg muscle in the mature male mouse (12 weeks of age). After six generations of selection the total hindleg muscle weight was 2.82, 2.66

and 2.11 grams in the heavy-muscle, control and light-muscle lines respectively. Selection for heavy muscle weight resulted in a 6 percent increase over the control line, whereas selection for light muscle weight resulted in a 20.7 percent decrease from the control line which indicates that selection for reduced muscle weight was considerably more effective than selection to increase muscle weight.

The correlated response in live weight at 12 weeks (age at which muscle weight was determined) exhibited a very similar pattern in the selection lines as the change in muscle weight. Consequently, the ratio of muscle weight to 12-week live weight was simular in the heavy muscle and control lines. However, the ratio of muscle weight to 12-week live weight declined in the light muscle line and was significantly lower in generations 4, 5 and 6. Body composition analysis conducted in generation 5 showed that the percent protein, either extract, moisture and ash was essentially the same in the heavy muscle, light muscle and control lines. This indicates that selection based on hindleg muscle system weight has not resulted in an alteration in the body composition of the mice.

Publications

McLellan, C. Reid, Jr. 1972. Response to divergent selection for hindleg muscle system weight in mice. Ph.D. Thesis. Oklahoma State University Library.

McLellan, C. Reid, Jr. and R. R. Frahm. 1971. Two-way selection for muscle system weight in mice. J. Anim. Sci. 33:203 (abstract).

Evaluation of the K^{40} Technique for the Determination of Muscle Potassium and Fat-Free Lean in Ground Meat

T. R. Carr, L. E. Walters, R. D. Morrison and R. F. Queener

Recent research concerning the element potassium and its relation to other body and carcass constituents has led to the development of whole-body K^{40} counting methods for determining differences in the lean content of live animals.

There are two properties of potassium that make its quantitative measurement in animals and their tissues both useful and practical. First,

the measurement of potassium is useful in live animal composition studies because potassium appears to be relatively independent of body fat and to make up a relatively constant proportion of the fat-free body when considered within species and age groups. Further, because a large proportion of the intracellular fluid occurs in the muscle and because of the high concentration of potassium in the intracellular fluid, potassium shows promise as an index of the amount of muscle present in an animal or a meat sample. Secondly, the measurement of potassium is possible because a small but constant proportion of potassium is radioactive. By measuring the amount of radioactivity arising, specifically from the potassium in an animal, instruments such as the O. S. U. whole-body counter have made it possible to measure the amount of potassium in meat animals and from these data to estimate the amount of muscle in the living animal with considerable accuracy.

The search for a rapid, accurate method for determining muscle potassium and fat-free lean in ground meat samples has prompted the investigation of two new detector configurations in the O. S. U. K^{40} whole-body counter. The development of such a technique could result in considerable savings in chemical analyses, as well as to initiate the

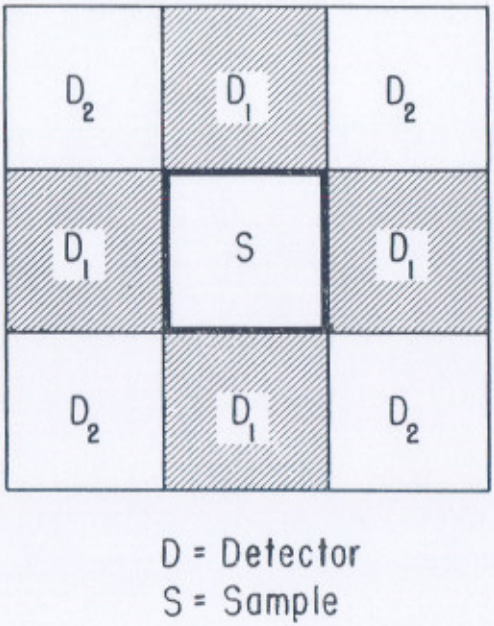

Figure 1. Schematic of Tunnel K^{40} counting configuration.

development of technology in this area applicable to improved quality control methods in the meat industry.

Experiment I. These studies involve the use of eight detectors (6½" X 6½" X 60") arranged in such a way as to create a tunnel in which samples can be placed for counting, Figure 1.

In this experiment only the D_1 detectors were used to monitor potassium radiation from the ground meat samples. Research is currently in progress in which all eight detectors are activated for monitoring and K^{40} counting.

Preliminary results using 40 pound sugar phantoms containing known concentrations of potassium (KCl) indicate that net K^{40} count is closely related to the concentration of KCl in the phantom as is shown in the plot of Logarithm-Net K^{40} counts versus potassium concentration, Figure 2.

Experiment II. A. In these studies, the phantoms were replaced by lean ground beef samples containing different levels of added fat and different concentrations of lean. A plot of the K^{40} counts (obtained when using the tunnel configuration described in Exp. 1) and ground beef composition is presented in Figure 3. These results also suggest a nther strong relationship between net K^{40} counts and lean concentration in the sample. Further work is necessary to more completely establish the counting efficiency of the system and to develop the necessary prediction equations for application to an analytical procedure.

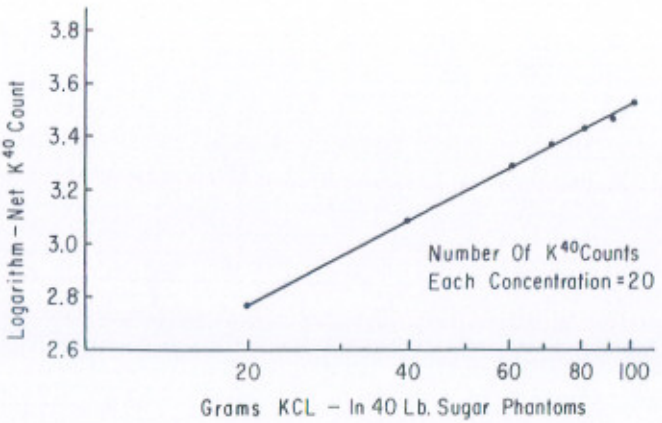

Figure 2. Logarithm-Net K^{40} count as related to potassium concentration.

Table 1. Composition of ground beef samples: Experiment II. A.

	Lbs. Lean Ground Beef	Lbs. Added Fat
Sample 1	30.0	10.0
Sample 2	32.5	7.5
Sample 3	35.0	5.0
Sample 4	37.5	2.5
Sample 5	40.0	0.0

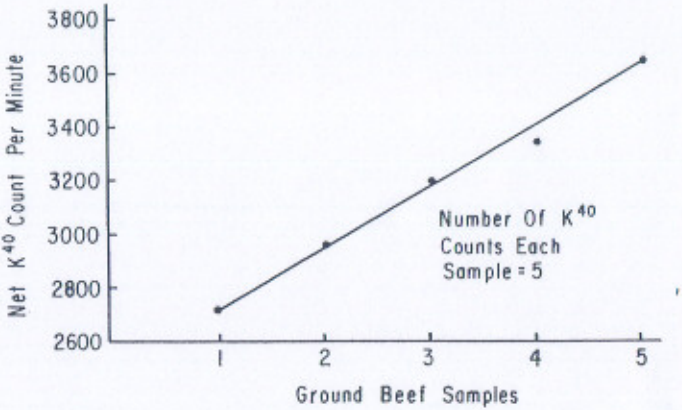

Figure 3. Net K^{40} count as related to different lean concentrations in in ground beef.

Experiment II. B. Another series of K^{40} evaluations were made using different levels of fat added to lean ground beef. The plot of net K^{40} counts and ground beef composition for this experiment is presented in Figure 4.

Table 2. Composition of ground beef sample: Experiment II. B.

	Lbs. Lean Ground Beef	Lbs. Added Fat
Sample 1	32.0	8.0
Sample 2	36.0	4.0
Sample 3	38.0	2.0
Sample 4	39.0	1.0
Sample 5	40.0	0.0

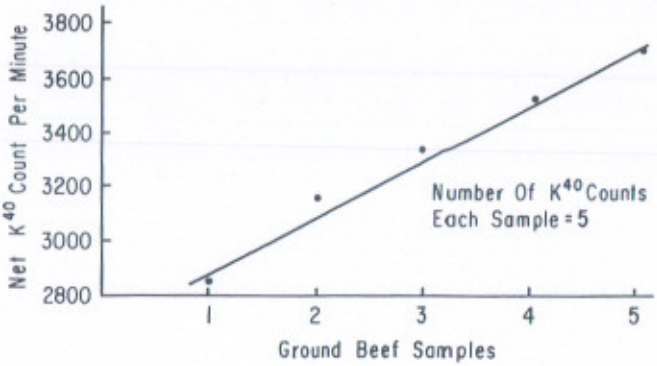

Figure 4. Net K^{40} count as related to different lean concentrations in ground beef.

Both Figures 3 and 4 suggest a linear relationship between net K^{40} count and known amounts of fat and lean in the ground meat samples. After further research and statistical analyses of the data, prediction equations may be developed which will perhaps enable one to estimate the fat-free lean percentages in ground meat samples by using the K^{40} counter.

On the basis of these preliminary results, a "cube counter" has been constructed which will accomodate a seven pound ground meat sample and allow for K^{40} monitoring through detector surfaces placed on all sides of the sample. This is in contrast to radiation monitoring from 4 sides of samples in the "tunnel" configuration described in Experiments 1 and 2 above. Thus, the "cube counter" more completely surrounds the sample with radiation detectors than is possible in the "tunnel" configuration. These studies are now in progress. The data will be analyzed statistically and a more complete report will be made at a later date.

A Characterization Of Myodegeneration Syndrome In Porcine Muscle

S. N. Falk, R. L. Henrickson, C. V. Maxwell and R. J. Panciera

Forty market weight Yorkshire hogs were used in this study. The animals were exercised on a treadmill and then slaughered at which time the intramuscular temperature and pH of the muscle were determined. Histochemical evaluation involving the DPNH-TR technique was used to determine the oxidative potential of the muscle. Carcass evaluation included color, firmness, marbling of the loin, lean cut yield, carcass length, loin eye area and weight. Chemical evaluation of the Longissimus dorsi included moisture and fat analysis. Fiber diameter and degree rigor were also measured and compared with shear data obtained from the Warner-Bratzler shear instrument.

No relationship was found between live weight and susceptibility to Myodegeneration Syndrome between groups, however, hogs with low initial muscle pH exhibited pre-slaughter characteristics of previously reported syndromes and had higher post-mortem intramuscular temperatures than those with intermediate and high initial pH. Carcass evaluation revealed no differences in chilled side weights, however, the "susceptible animals" had a greater percentage of live and carcass lean cuts and were shorter and more compact than the "normal" animals.

Differences in quality were readily observable and agreed well with previous investigations of pale, soft, exudative pork (PSE). "Abnormal" and "intermediate" carcasses had larger Longissimus dorsi areas and weights. Also animals with low and intermediate initial pH had lower percentages of fat and higher percentages of moisture than those with high initial pH. Histological analysis revealed no differences in fiber diameter among groups, however, the degree of rigor (percent kinkiness) was higher when the initial muscle pH was low or intermediate and agreed well with shear data.

The histochemical analysis demonstrated that "abnormal" and "intermediate" animals had fewer red and more intermediate muscle fibers than did "normal" animals, while white fiber content was relatively consistent between groups. These data agreed well with previous investigations.

Physical Properties of the Skeletal Muscle Fiber

R. L. Henrickson and J. C. Marsden

The shear force of muscle tissue has been extensively investigated, but rarely at the fiber level. Most studies have been concerned with cooked pieces of meat one-inch in diameter. This project involves an investigation of shear force and related physical properties of the muscle fiber. Continued research will determine the influence of these properties on tenderness.

The sartorius muscle from 18 sides of beef were excised hot at 2, 5, and 8 hours postmortem. Those from the opposite side were excised after the carcass had chilled at 32°F. for 48 hours. One hundred fibers from each muscle were appraised for shear force, fiber diameter, and degree rigor-mortis. Thus, the 1800 fibers from the hot excised muscles were compared to the 1800 fibers excised after the muscle had chilled.

Fiber diameter and degree rigor of fibers from the cold excised muscle showed little variation. For the muscles excised hot, the fiber diameter and degree rigor decreased as the holding period increased.

In terms of average shear force (g/u^2) for individual muscle fibers, the cold excised muscles showed a difference ranging from 1.74×10^{-3} to 1.83×10^{-3} g/u^2. The fiber from the hot excised muscles ranged from 1.71×10^{-3} to 2.90×10^{-3} g/u^2. In general, the shear force decreased as the holding time increased.

For fiber diameter, shear force, and degree rigor the holding time (2, 5, and 8 hours) treatment (hot or cold), and treatment holding time interaction were all significant at the ($p<.05$). Correlations and repeatability studies are in progress.

Fiber tensil strength investigations utilizing the Instron Universal Testing Machine have been accomplished using 25 fibers from each of 6 muscles.

Influence Of "Hot" Boning On Bovine Muscle

Curtis Lynn Kastner and R. L. Henrickson

The "hot" boning of bovine carcasses has received limited study, but "hot" processing of porcine muscle has been studied in detail. Processing of pork prior to chilling has proven advantageous; thus, it was hypothesized that the bovine carcass would also lend itself well to "hot" boning. Six Hereford steer carcass were assigned to each holding period. Each carcass was split and one side was "hot" boned while the other side was "cold" boned. Three post-mortem holding periods (two, five, and eight hours) for the "hot" boned sides were compared to a 48 hour conditioning period for the "cold" boned sides. Muscle quality and yield were compared for "hot" versus "cold" boning.

Yield was significantly less for "hot" boning as compared to the control in both the five and eight hour holding periods. The muscle moisture and fat percentages for "hot" and "cold" boning were not significantly different for all holding periods. The pressed fluid ratio was smaller for "hot" than "cold" boning in the two hour holding period, but the "hot" boned pressed fluid ratios were larger than the control in the five and eight hour holding periods.

Shear forces were statistically greater for "hot" boning than the control in the two and five hour holding periods, but conditioning for eight hours produced a non-significant difference in shear force for "hot" versus "cold" boning. Significant differences in color value scores for "hot" and "cold" boning were found for all holding periods. Even though significant color value differences were reported a color panel only detected the color difference between "hot" and "cold" boning in the two hour holding period.

A taste panel could not detect significant differences in flavor between "hot" and "cold" boning in all conditioning periods. Cooking loss percentages were not significantly different between "hot" boning and the control for each holding period. If muscles are excised "hot" at five to eight hours post-mortem, then "hot" boning is feasible considering the parameters evaluated in this study.

Procedure For Live Biopsy of Bovine Longissimus Dorsi Muscle

J. J. Guenther, T. R. Thedford and E. W. Jones

To study certain biochemical, physiological or structural characteristics of bovine muscle it is often necessary to obtain muscle samples from the live animal at various periods during the animal's growth cycle. The procedure to follow was developed to satisfy this need. (Note: As the longissimus dorsi is a convenient muscle to utilize in studies of this nature, the procedure is written for that muscle. However, it may be applied to other muscles as well.)

Preparation For Surgery

The animal is restrained either manually or via a squeeze chute. Clip or shave hair from area to be sampled. The T_{12} to L_4 area of the L dorsi is a desirable sampling area. Cleanse area by washing with surgical soap, alcohol and finally, iodine.

Anesthesia

Five milligrams per pound of body weight of Surital[R] are injected intravenous via the jugular vein. Concentration of the solution is 10 percent, primarily due to ease of injecting. The anesthesia should be given rapidly. Surgical anesthesia is attained in 1-1.5 minutes and will be maintained about 10-15 minutes. The animal will normally be able to sit up in about 20-25 minutes after anesthetizing and should be placed on its sternum at this time. The animals will be able to stand in about 35-45 minutes. (Note: Any additional administration of the drug should be made cautiously and experienced personnel should be on hand to revive animal.) Animals should be off feed 24 hours prior to anesthesia.

Surgery

A lateral incision through the skin, about 10 cm., is made, transverse to the muscle. The fascia and fat are not disturbed. Skin is retracted via allis tissue forceps to allow admission of biopsy device. Biopsy device consists of a stainless steel corer powered by an electric hand drill. A 1.0-2.5 cm. diameter corer is used, depending upon sample size desired. The corer is admitted slowly, but steadily, to deep border of muscle. Curved scissors are employed to clip sample at deep end. Wound is dust-

ed with Furacin[R]. Closure is made with 3 vertical mattress sutures of Vetafil. Sutures should be removed 10-14 days post-surgery.

All instruments, including the stainless steel corer are sanitized by autoclaving, then stored in a 1-4000 solution of nolvalsan. The biopsy size is normally 10-15 grams. Animals slaughtered 4 weeks post-surgery show almost complete tissue recovery.

Swine

The Effect of Ration Ingredient Change on Pig Performance

W. G. Luce and C. V. Maxwell

Two trials have been conducted involving 128 growing-finishing swine to measure the effect of ration ingredient change on pig performance.

Treatments involved in both trials were (1) a basal milo-soybean meal ration fed throughout the trials; (2) the cereal grain portion of the rations (milo, corn, and wheat) was rotated every 7 days; (3) the protein source (all soybean meal, ⅓ meat and bone scraps and ⅔ soybean meal, and ⅓ peanut meal and ⅔ soybean meal) was rotated every 7 days; (4) both the cereal grain and protein sources, as outlined in Treatments 2 and 3, were rotated every 7 days (9 different combinations). Average daily gains, average daily feed intake, feed efficiency, and probed backfat thickness appeared to be similar for all treatments.

The data are presently being analyzed further and will be published at a later date.
