Meat and Carcass Evaluation

A Method for Measuring Shear Force for An Individual Muscle Fiber

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Abstract

The microsensitive shear instrument, a device designed to measure the shear force of individual muscle fibers, was elvaluated in a uniformity trial, and in a comparison of bovine Sartorius muscle excised after being conditioned in the carcass for 2, 5, and 8 hours, at 16° C. Each of 299 randomly drawn fibers were evaluated for diameter, percent kinkiness, and shear force.

In a comparison of "cold" excised Sartorius muscle fibers and Sartorius fibers conditioned for 2, 5, and 8 hours post-morten, 3600 fibers were evaluated for diameter, percent kinkiness, and shear force. Data from the uniformity trial established the feasibility of measuring shear force for individual muscle fibers. The mean shear force for the 299 fibers was 2.30 gm./U^2.

In the comparison of the Sartorius muscle excised "Cold" and those excised after 2, 5, and 8 hours post-mortem, a difference was found to be statistically significant (P 0.01) for the 2 hour post-mortem holding period for diameter, percent kinkiness, and shear force. At the 5 and 8 hour conditioning periods, no significant differences were detected for the three fiber parameters.

The Potassium Concentration in Four Major Protein Fractions of Bovine Longissimus Muscle

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Total muscle, or fat-free lean, and total muscle potassium are, purportedly, highly correlated. In fact, this concept forms the basis upon which various prediction equations to estimate total fat-free lean in live

animals, via live animal ^{40}K analysis, have been developed. This apparent importance of and extensive use of total muscle potassium in estimating the lean content of breeding stock has prompted the authors to determine the concentration of potassium in the major protein fractions comprising whole muscle.

For this study, samples of longissimus muscle were obtained from ten mature beef steers. The steers were of the choice grade and averaged 432 kg. alive. Following procedures developed in our laboratory the muscle samples were partitioned into the following protein fractions: Sarcoplasmic; Myofibrillar; Stroma and Lipo-protein. The potassium concentration of each of these fractions was determined by Atomic Absorption Spectroscopy. Digestion of the protein fractions was accomplished in a perchloric (70 percent) -nitric acid mixture (3:1). Results were expressed as milligrams potassium per gram of wet tissue.

The mean values from the muscle potassium analyses are shown in Table 1. These results are presented on an absolute as well as on a percentage basis. The data show that whole bovine longissimus muscle contains about 3.612 mg potassium per gram of tissue. It is obvious from these results that muscle potassium is located primarily in the Sarcoplasmic protein fraction of muscle, which contained 3.570 mg K/g. tissue or 98.84 percent of the total muscle potassium. The myofibrillar fraction contained only 0.61 percent of the total potassium, which was a little more than twice the amount found in either the Stroma or Lipoprotein fractions.

These data raise some interesting questions as to the ultimate quantitative and qualitative attributes of meat carcasses if the selection of breeding stock is based too strongly on the muscle potassium: fat-free lean relationship. Further study is planned to elucidate some of these effects.

Table 1. Potassium Concentration in the Major Protein Fractions of Bovine Longissimus Muscle

	Muscle Fraction				
	Total	Sarcoplasmic	Myofibrillar	Stroma	Lipo-Protein
mg. K/g. tissue	3.612[1]	3.570	0.022	0.010	0.010
% of total	100.0	98.84	0.61	0.28	0.28

[1] All values are averages of 10 muscle samples

Use of K^{40} Net Count as a Monitor of Body Composition Changes in Growing and Fattening Beef Cattle and Swine

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Earlier work at this station dealing with the association between live net K^{40} count and pounds of fat-free lean in the carcass of forty yearling Angus bulls and sixty Yorkshire barrows has stimulated considerable interest in this method as an aid to more effective livestock selection. Results of these and other studies form the basis of prediction equations currently in use with the K^{40} technique at the O.S.U. Live Animal Evaluation Center for appraising 1000 pound beef cattle and 220-240 pound hogs for muscle content on a "custom" evaluation basis as well as for continuing live animal evaluation research.

Among known sources of variation in results from the application of radiation technology to problems of a biological nature, such as with meat animals, are included such variables as sample to detector geometry, size and conformation of the test animals, as well as the age, sex and condition of the animals at the time of evaluation.

Previous research at the Oklahoma Agricultural Experiment Station has been conducted with groups of animals that were as uniform in age, breed, weight and condition as was possible to obtain in order to subject the O.S.U. K^{40} whole-body counter to a critical test of its capability to estimate differences in muscling among meat animals.

Questions have arisen concerning the application of this technique to cattle and swine of younger ages and lighter body weights with the thought that considerable saving in time and expense could possibly be achieved if K^{40} prediction equations were available for such animals. With these thoughts as a background, research is currently in progress which is designed to answer questions pertinent to the application of the principles of radiation technology (K^{40}) to the live evaluation of more youthful, lighter weight beef cattle and swine. The following is the plan of research currently in progress:

Cattle: Ninety-six beef steers representing four weight groups and two body types are being evaluated using new detector arrangements in the O.S.U. K^{40} counter. The arrangement of detectors provides for a radiation monitoring system located as close to the animal as is possible in attempts to improve K^{40} counting efficiency over a range of live weights. In order to accomplish this, new detector hangers have been constructed in accordance with height and width dimensions of the cattle in each of four weight categories.

Three replications of 16 steer calves each weighing approximately 400 pounds and representing "intermediate" beef type are being randomly allotted to slaughter weight groups of 500, 700, 900 and 1100 pounds and placed on feed in the dry lot. From each replication, 4 steers are allotted to each weight group, making a total of 12 "intermediate" type steers for each of the four slaughter weights. Three additional replications of 16 steer calves each weighing approximately 400 pounds and representing "large scale, growthy" beef type are being randomly allotted to slaughter weight groups of 500, 700, 900 and 1100 pounds and placed on feed in the dry lot.

From each replication four steers are being allotted to each weight group, making a total of 12 "large scale, growthy" type steers for each of the four slaughter weight groups. As the steers reach the shrunk live weights of 500, 700, 900 and 1100 pounds, they are taken off-feed for 24 hours, thoroughly washed to remove possible radiation contaminating materials and then evaluated by the K^{40} whole-body counter, using the detector configuration which most closely fits that particular weight and type.

Those steers designated at the outset of the experiment to be slaughtered at a particular weight are moved to the Meat Laboratory for slaughter and carcass evaluation. The carcasses are evaluated for carcass quality and cutability grade along with additional measurements including average fat thickness at 12th rib, rib eye area, weight of boneless, closely trimmed round, loin, rib and chuck, total pounds of fat trim and total boneless, closely trimmed minor wholesale cuts. Chemical analyses for ether-extract and muscle potassium in the boneless closely trimmed muscle mass from the right half of each carcass are in progress. Fat-free lean is determined by subtracting total ether-extractable materials from the weight of the boneless, closely trimmed muscle mass from the right carcass half.

Correlation and regression studies of the association between net K^{40} count and fat-free lean in the animals at different ages and weights will then be made. These studies also include an attempt to describe possible changes in the pattern of potassium concentration in selected beef muscles over a range of ages and live weights in each of the two types. For this purpose, chemical analyses for potassium are being conducted on the longissimus dorsi, trapezius, supraspinatus, semitendinosus and biceps femoris muscles from each carcass. Slaughter and carcass evaluation is nearing completion for Replication I for both types of cattle. A full report of the results will be made at a later date.

Swine: One hundred market barrows (50 Hampshire and 50 Yorkshires) representing five weight groups are being evaluated by the K^{40} whole-body counter. A new detector arrangement is utilized in the count-

ing of the swine in an attempt to improve K^{40} counting efficiency over a range of live weights. The new arrangement of detectors provides for more flexibility in the adaptation of the instrument to pigs over a range of live weights from 100 to 300 pounds than has been possible in previous swine studies.

Ten replications of 10 feeder pigs each weighing 60-70 pounds are randomly allotted to slaughter weight groups of 100, 150, 200, 250 and 300 pounds and placed on a growing-fattening ration. From each replication, two pigs are randomly assigned to each slaughter weight group, making a total of 20 pigs for each of the five slaughter weights as is shown in Table 1.

As the pigs reach the shrunk live weights of 100, 150, 200, 250 and 300 pounds, they are taken off-feed for 24 hours, thoroughly washed to remove any foreign material that might influence the K^{40} count and then evaluated by the K^{40} whole-body counter, using the dector configuration which most nearly fits that particular weight. Those pigs which were designated at the beginning of the experiment to be slaughtered at a particular weight are taken to the Meat Laboratory for slaughter and carcass evaluation. Live animal measurements taken are a whole-body K^{40} count and a lean-meter probe. Carcass measurements taken include length, average backfat, loin eye area, weight of trimmed ham, loin and shoulder, weight of total fat trim, and weight of boneless, closely trimmed lean from the right carcass half.

Ether-extract and potassium analyses are conducted on ground lean samples of the right carcass halves and total pounds of fat-free lean are determined by difference. In addition, the biceps femoris, semimembranosus, and longissimus dorsi muscle are excised and analyzed chemically for potassium and ether-extract.

Table 1. Experimental Design

Replication	Slaughter Weight Groups (pounds)				
	100	150	200	250	300
I	2[1]	2	2	2	2
II	2	2	2	2	2
–	–	–	–	–	–
–	–	–	–	–	–
–	–	–	–	–	–
–	–	–	–	–	–
X	2	2	2	2	2
Total	20[2]	20	20	20	20

[1] Number of animals per replication per weight group.
[2] Total number of animals per weight group.

Two replications of this work have been completed and one-half of the animals involved in Replications III, IV, V and VI have been slaughtered. Ether-extract and potassium analyses have been conducted on the muscle samples taken from the lean of those animals in Replications I and II. Statistical analysis of the data will be conducted.

Preliminary Results:

While statistical analyses are not available at this time, graphic plots of certain of the data point to trends in the data and are presented in Figures 1 and 2.

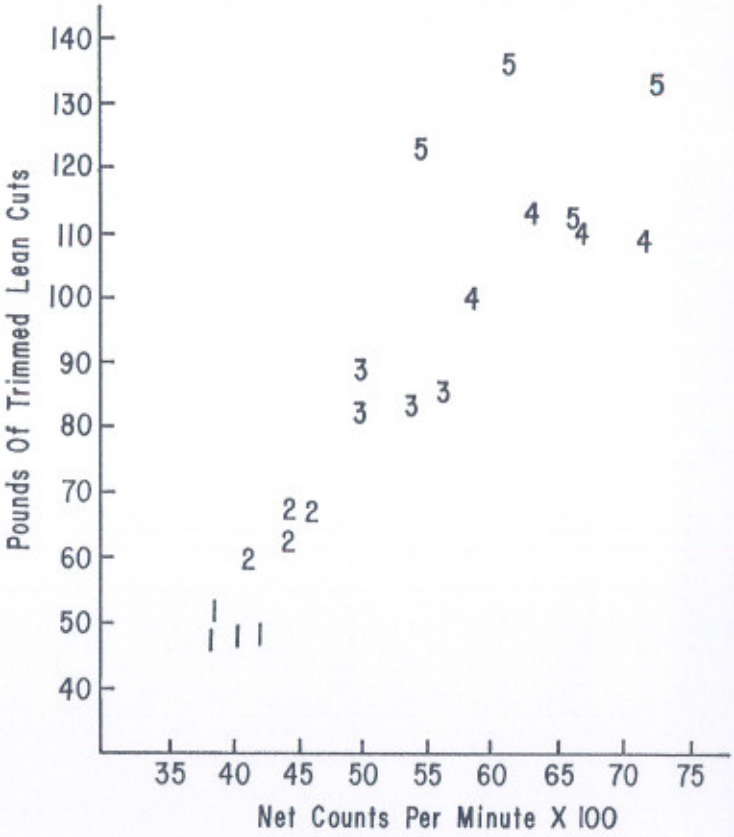

Figure 1. Net K^{40} count and weight group as related to pounds of closely trimmed lean cuts.

The plotted numbers 1, 2, 3, 4 and 5 represent animals in the weight groups 100, 150, 200, 250 and 300 pounds, respectively.

The plot of net K^{40} count, live weight and pounds of closely trimmed lean cuts is presented in Figure 1. There appears to be a rather strong positive linear relationship between K^{40} count and total pounds of closely trimmed lean cuts.

These preliminary data suggest that as slaughter weights of the pigs increase, there is greater variation in pounds of lean cuts among animals of the same weight group. Some of this variation may be "real" while a portion may be attributable to one's inability to remove equal amounts of intermuscular fat from the lean cuts. The inability to remove any of the intramuscular fat (marbling) from the lean cuts may also be a source of variation. At least a part of this variation is to be expected, inasmuch as pigs in the 100 pound group are much leaner (i.e., have a

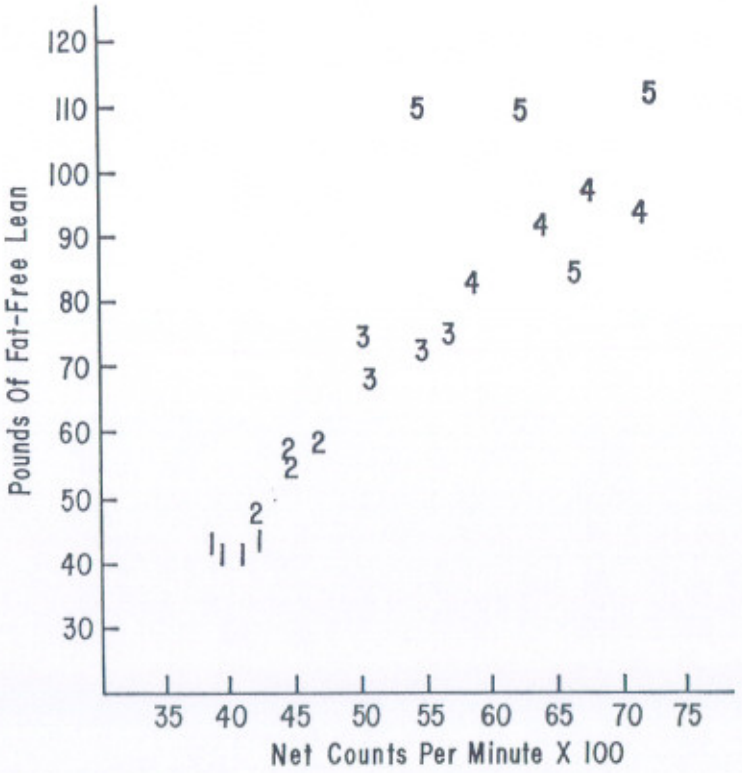

Figure 2. Net K^{40} count and weight group as related to pounds of fat-free lean.

The plotted numbers 1, 2, 3, 4 and 5 represent animals in the weight groups 100, 150, 200, 250 and 300 pounds, respectively.

much lower fat to lean ratio) than those of the 250 and 300 pound groups.

In lean and fat separation, one is able to remove much more fat proportionately from the cuts of the carcass from the 100 pound pig than from those in the heavier weights. Thus, lean cuts from heavier weight groups are not as good an estimator of carcass muscle as are those from the lighter weight groups of pigs.

A plot of net K^{40} counts, live weight and pounds of fat-free lean from pigs in Replications I and II is presented in Figure 2. The plot of these data suggests a rather strong positive linear relationship between pounds of fat-free lean and net K^{40} count in each of the five weight groups. There appears to be greater variation in pounds of fat-free lean among animals in the heavier weight groups than in the light weight groups. Further, the association between K^{40} net count and pounds of fat-free lean does not appear to be as strong at live weights of near 300 pounds as is apparent in the lighter weights.

A part of this variation among animals in heavier weights may be attributed to the self-absorption of gamma rays emitted from the muscle in the animal. The larger the animal, the greater is the likelihood that a gamma ray will lose part of its energy before leaving the animal and interacting with the detectors thus reducing the number of disintegrations detected.

Another possible source of variation may involve the fat. We do not know, for example, to what extent a layer of fat may act as a shield, thus influencing the number of gamma rays that have sufficient levels of energy to pass through the animal mass and become detectable.

While the plots of the data in Figures 1 and 2 are quite similar, there appears to be a greater linear trend in the 100, 150, 200 and 250 pound groups in fat-free lean estimation than for that of trimmed lean cuts. A complete report of the results of this study will be made at a later date.
