Meat and Carcass Evaluation

Influence Of Level Of Potassium Intake on Net K^{40} Count In Beef Steers

Rodger Johnson, L. E. Walters and J. V. Whiteman

Thirty-six Angus-Hereford crossbred steers were used to study the influence of 3 levels of dietary potassium on net K^{40} count, blood serum potassium levels and muscle tissue potassium concentration. The 3 diets (approximately 50 percent roughage-50 percent concentrate) were alfalfa-corn, wheat straw-corn and a diet consisting of 1.7 lbs. KCL added to each 100 pounds of the wheat straw-corn ration. Potassium levels of the 3 diets were 1.31, 0.29 and 1.03 percent, respectively. The steers were alloted into 3 groups and each group placed on one of the above diets for a two-week feeding period. Appropriate K^{40} counts and tissue samples were taken at the end of each feeding period. At the end of the two week feeding period, steers were placed on a different ration so that at the end of 3 two-week periods, each steer had received each ration. K^{40} data were collected on steers unshrunk and after 24 hours shrink. The experiment was balanced so that carry-over effects of each ration from one period to the next could be evaluated.

Statistical analysis of the data indicate that carry-over effects appeared negligible for all treatments. Steers fed the alfalfa diet had the highest net K^{40} count and steers on wheat straw the lowest. This difference was considerably larger when determined on unshrunk steers than after the same steers were shrunk for 24 hours (without feed and water).

Preliminary analysis of the data indicate that the difference after 24 hours shrink is large enough to suggest that the diet cattle are receiving prior to K^{40} counting may influence the accuracy of K^{40} estimates of lean in cattle. Dietary potassium levels appeared not to influence blood serum potassium levels or muscle tissue potassium levels. However consistent differences between animals were evident in blood serum and muscle tissue potassium concentrations.

These data indicate that if estimates of lean in cattle are to be made from K^{40} net count, the same ration should be fed to all animals for a period of time prior to counting. Thus it appears that the K^{40} counter is the best adapted to comparison of similar weight animals that have been fed and managed alike for a period of time prior to K^{40} evaluation.

These data are undergoing further analysis and a more complete report will be available at a later date.

Net K^{40} Count As A Predictor Of Fat-Free-Lean In Cattle And Swine

Lowell E. Walters

Recently, certain support instrumentation has been added to the equipment at the Live Animal Evaluation Center which is needed in the calibration and maintenance of the K^{40} counter. Through the incorporation of these facilities into the evaluation program, improvement may be achieved in the capability of the counter to predict pounds of fat-free-lean in both cattle and swine. The following described studies incorporating these facilities are in progress.

Cattle

Thirty-six 900-1000 pound Choice quality slaughter steers were counted in the whole-body counter at the Live Animal Evaluation Center in the fall of 1970 for the purpose of re-evaluating K^{40} net count as a predictor of total muscle in beef steers. The steers were alloted to six groups and were processed through the Evaluation Center and the O.S.U. Meat Laboratory during six successive weeks. The steers were thoroughly washed and shrunk for 24 hours prior to counting. Five 2 minute counts were taken for each steer.

Following slaughter, the right half of each carcass was separated into lean, fat and bone. The separable lean was sampled for chemical analysis which is currently in the final stages of completion. Ether extract content of the separable lean will be used in order to determine the total quantity of fat-free-lean for each animal. Statistical analysis of the data will be completed to ascertain the relationship between net K^{40} count and pounds of total fat-free-lean.

Hogs

Earlier research designed to monitor muscle development in growing and finishing swine using the large cattle K^{40} counting equipment pointed to the need for a different detector arrangement, especially for 100-200 pound pigs. It appeared from this work that for greater counting efficiency, the detector logs needed to be much closer to the pigs than was possible in the larger cattle arrangement: therefore, six detectors were remounted in a smaller configuration and an experiment conducted to determine the improvement, if any, with "lean cuts" in the carcasses from counted animals as the end-point. Since this study showed promise of improvement in counter efficiency using the new detector design, 23 Hampshire, 21 Duroc and 21 Yorkshire market barrows weighing 215 pounds were counted in the fall of 1970 to further study counting efficiency.

In this work the animals were thoroughly washed and shrunk 24 hours prior to counting. After slaughter, the warm carcasses were mounted in a standing position and returned to the counter for carcass counting efficiency studies. The carcasses were chilled, split and the right half separated into lean, fat and bone. The separable lean was sampled for chemical analysis which is nearly completed at this writing. Fat-free lean determination will be made from ether extract analysis of the ground lean samples from each carcass and all the data treated statistically.

Estimation Of Fat Thickness And Loin Eye Area By Ultrasound

Lowell Walters and Michael May

During recent years, several probing techniques have been studied in efforts to learn more about the composition of meat animals without resorting to slaughter and chemical analysis of the animals. Among these techniques is that of ultrasound, of interest primarily because of its promise in providing some information relative to thickness of subcutaneous fat and the size (shape) of muscles such as the loin eye in the animal alive. These two estimates of composition have been shown to be of some value as predictors of composition.

Ultrasonics refers to sound waves or vibrations at a frequency above the audible range of the human ear. This ultrasonic energy is mechanical vibration that can be focused in a narrow beam which may be transmitted and reflected in much the same way as a beam of light. The technique is useful in animal appraisal because of the differential rate of transmission of the sound in tissues that differ in density such as fat and lean. Thus, when a beam of these sound waves passes from fat into lean, an "echo" is established in the calibrated instrument from which a fat depth and a muscle size and shape can be estimated.

The Scanogram is an instrument under study in this research which makes use of this principle, coupled with a Polaroid film pack and a mechanically synchronized drive which makes possible a plot of "echos" representing fat layers and muscle systems on the Polaroid film.

Results from studies with slaughter cattle and hogs indicate that the Scanogram can estimate fat thickness in both species with greater accuracy than loin eye area. With cattle, the results have been somewhat variable depending upon the function of the electronics in the instrument. Aver-

age errors for fat thickness and rib eye area at the 12th rib location on one group of ninety-eight 1000 lb. steers were found to be 0.17 inches and 0.59 square inches, respectively. The average errors for a group of thirty-six 1000 pound slaughter steers were 0.11 inches and 0.74 square inches for fat thickness and rib eye area, respectively. A second group of 36 slaughter steers was evaluated at a time in which the machine was less stable and in this case, rib eye areas were missed on the average by 1.28 square inches and fat thickness by 0.17 inches.

In the studies with 200-225 pound slaughter barrows and gilts the results have also been quite variable. In one group of 16 market barrows, the average error for loin eye area estimates was 0.63 square inches and for backfat thickness, .096 inches. With another group of 67 market weight hogs the average errors for fat and loin eye area were found to be 0.10 inches and 0.84 square inches, respectively. The correlation between estimated fat thickness and percent lean cuts of live weight was -0.65. In the fall of 1970, a group of 43 market hogs were evaluated by the Scanogram in a somewhat different fashion to include an estimate of fat thickness made on the midline of the back from the thirteenth rib to a point eight inches posterior. In this work the correlation between actual "linear fat" and the estimated was found to be +0.78. However, correlations between the linear fat estimate with lean cut yield and estimated average backfat thickness with lean cut yield were found to be almost identical (-0.59 and -0.58).

Mouse Selection Studies As An Aid To Animal Breeding Research

R. R. Frahm, I. T. Omtvedt and C. R. McLellan, Jr.

The economic importance of growth rate is well recognized by all segments of the livestock industry. It is most desirable from the standpoint of efficiency to select breeding stock with superior genetic capability for rapid growth at the earliest age possible. Determination of the optimal age at which selections can be made effectively requires a basic understanding of the genetic relationships that exist among growth rate at different stages of the growth curve. Experiments are underway with the livestock species to provide information on this very fundamental question, however, it will be several years before adequate answers will be available. This type of research requires large numbers of experimental

animals to obtain good measurement of these genetic relationships coupled with the fact that it is a slow process because of the long generation intervals involved with the livestock species.

Mice are well suited for genetic studies to explore basic genetic relationships and provide an indication of what can be expected with the livestock species. Large numbers of mice can be economically maintained in a relatively small amount of space under well controlled environmental conditions. Since 4 generations are produced each year, results are obtained considerably faster with mice than with the livestock species.

Project 1405 was initiated to measure direct and correlated response to selection for preweaning and postweaning rate of gain in mice for the purpose of determining the basic genetic relationships between growth rate at these two intervals in the life cycle. This project consists of 6 selection lines of 20 litters each (3 lines selected on basis of individual weaning weight and 3 lines selected on the basis of weight gain from 3-6 weeks of age) and a random mating control line of 40 litters that is used for measuring genetic changes that occur in the selection lines.

After 2 generations of selection, the average 3-week weight of the 3 lines selected on the basis of weaning weight was 0.76 gram (7.5 percent heavier than the control lines and the average daily gain from 3-6 weeks of age for the 3 lines selected for postweaning growth rate was 0.072 gram/day (11.0 percent greater than the control lines which indicates that direct selection for these two traits has been effective. Average daily gain from 3-6 weeks was essentially the same in the weaning weight selection lines as the control lines indicating little correlated response to date for postweaning gain. However, the average 3-week weight of the postweaning gain selection lines was 0.48 gram (4.7 percent) heavier than the control lines indicating that some correlated response for 3-week weight has apparently been realized.

In order to determine if the total weight of a particular muscle system can be altered by selection, a study involving two selection lines has been initiated. One line is being selected on the basis of the heaviest weight of the hindquarter muscle system and the other on the basis of the lightest muscle weight in the mature mouse (12 weeks of age). After 3 generations of selection, the heavy-muscle line had an average hindquarter muscle weight of 2.59 gram which was 14.1 percent heavier than the 2.27 gram average muscle weight of the light-muscle line. These results indicate that direct selection to alter the weight of a specific muscle system has been effective to date, however, more generations of data will be required to reach specific conclusions. Of particular interest in this study will be whether live weight of the mice change proportionally with the alteration in muscle weight or whether the altered muscle weight will reflect a change in the ratio of muscle weight to live weight.

Hot Boning Of Bovine Muscle

C. L. Kastner and R. L. Henrickson

Processing meat prior to chilling is of commercial interest; consequently, extensive research has been conducted on porcine muscle. Bovine muscle has received limited attention, thus a meaningful research project would consist of evaluating "hot boning" of the beef carcass.

Fabrication of th bovine carcass prior to chilling has several potential advantages. The economy of this process is reflected by the fact that waste fat (20-30 percent) and bone (15-18 percent) are removed prior to chilling thus conserving on cooler space and total refrigeration input. A boneless closely trimmed product, produced from "hot boning" could lend itself well to portion control and marketability.

The objective of this investigation is to evaluate the feasibility of "hot boning" of the U.S. Good grade beef carcass with respect to yield, juiciness, tenderness, flavor, and color.

Even though this current research project is not completed there are some indicated trends considering the test parameters. When "hot boning", yield does not appear to be significantly different from boning a cold carcass. Removing muscle from the skeleton while it is still hot appears to have no marked effect on the flavor or juiciness as evaluated by a taste panel, percent moisture, or the Carver Press. Fresh meat color is slightly darker for the hot boned muscle but this color is not undesirable. Color differences are difficult to detect unless a direct comparison is made with the cold boned muscle. To date all color results have been based on visual color panel evaluations.

In conjunction with the panel, a Photovolt Reflection Meter is used to objectively measure hue, value, and chroma so that the authors will substantiate the visual color apprasial. Tenderness appears to be the primary problem when muscles are removed from the hot carcass. This would be expected because hot excised muscle can freely contract during rigor mortis. Muscles left on the skelton until rigor is complete, do not extensively contract due to their muscle and/or bone attachments. Therefore the cold boned muscles are more tender as evaluated by a tenderness panel and the Warner-Bratzler shear apparatus.

With minor modifications in the existing process, the authors feel that the tenderness problem may be resolved.

The Effect Of Ethylene Diamine Tetraacetic Acid On Bovine Myosin Adenosine Triphosphatase

J. J. Guenther

Bovine myosin was isolated from the longissimus dorsi muscle of mature, choice-grade hereford steers. Myosin ATPase activity was determined at 0°C and expressed as micromoles inorganic phosphate released per milligram protein per minute.

Factors studied were Ethylene Diamine Tetraacetic Acid, E.D.T.A. level (0, .005, .01, .02, .04mM/ml), ionic strength of ATPase incubation system and the influence of Ca^{++} activation. Results showed that both E.D.T.A. and the ionic strength of the incubation system had a highly significant effect on myosin ATPase activity and that the effect of E.D.T.A. was strongly influenced by the ionic strength of the incubation system. E.D.T.A. functioned as an ATPase activator in the high ionic system, but as an inhibitor at low ionic strength.

In the high ionic strength system, with no added $CaCl_2$, maximum ATPase rate occurred at 0.01 mM concentration of E.D.T.A.; whereas in the presence of $CaCl_2$, maximum acceleration did not occur until the E.D.T.A. concentration exceeded that of $CaCl_2$. It was also noted that E.D.T.A., at a concentration equivalent to $CaCl_2$ (0.01 mM), had a greater activating effect on myosin ATPase than Ca^{++}. In the low ionic strength system, which contained $CaCl_2$, E.D.T.A. suppressed myosin ATPase activity. The addition of E.D.T.A. had little effect on myosin ATPase activity in the low ionic strength incubation system which did not contain $CaCl_2$. Partially supported by Market Quality Research Division, ARS, USDA, Cooperative Agreement 12-14-100-9348 (51).

Amino Acid Composition Of Bovine G-Actin

J. J. Guenther

Bovine G-actin was purified according to procedures previously reported. Amino acid analyses were carried out on a Beckman Model 120C automatic amino acid analyzes according to the standard methods of Stein and Moore. G-actin samples (4.8305 mg/ml) were acid hydrolyzed at 110°C for 12, 24 and 72 hours in sealed, evacuated tubes.

The values for threonine, serine and half-cystine were determined by extrapolation of the data to zero time of hydrolysis, since these amino acids were partially destroyed when exposed to prolonged acid hydrolysis. The value for ammonia was calculated by subtracting losses in serine, threonine and half-cystine after 24 hours hydrolysis, from the observed ammonia value at 24 hours.

The data from the amino acid analyses are shown in Tables 1, 2, and 3. After 12, 24 and 72 hours acid hydrolysis amino acid recovery was 96.35, 97.44 and 89.92 percent, respectively. A significant difference existed between recoveries at the 12 and 72 hour period.

At the 24 hour period, 57 glutamic acid and 44 aspartic acid residues were obtained (Table 2). This indicates that the isoelectric point of bovine G-actin is on the acidic side. Methionine had the smallest number of residues, 7 per molecule. Bovine G-actin also contained considerable quantities of neutral amino acids such as alanine (38 residues/mole), glycine (36 residues/mole) and leucine (34 residues/mole). These values agree with G-actin from rabbit muscle. However, rabbit G-actin has a much greater amount of sulfur-containing amino acids. For example, rabbit G-actin contains 20 methionine residues per mole, whereas bovine G-actin contains only 7.

The minimal molecular weight of bovine G-actin can be calculated

Table 1. Amino Acid Recoveries After Acid Hydrolysis

	mg/4.8305 mg G-action		
Amino Acid	12 hr hydrolysis	24 hr hydrolysis	72 hr hydrolysis
Lysine	0.22141	0.24601	0.23898
Histidine	0.10550	0.13188	0.12412
Ammonia	0.80743	0.08045	0.06889
Arginine	0.26828	0.28396	0.27176
Aspartic Acid	0.46718	0.47117	0.44508
Threonine	0.31442	0.30132	0.26392
Serine	0.21858	0.20282	0.15385
Glutamic Acid	0.63707	0.67091	0.59205
Proline	0.20953	0.20147	0.09249
Glycine	0.22070	0.21770	0.21019
Alanine	0.28508	0.27439	0.26156
Half-cystine	0.10572	0.08169	0.06343
Valine	0.20852	0.23312	0.23804
Methionine	0.09549	0.08206	0.07281
Isoleucine	0.29250	0.30562	0.31375
Leucine	0.35022	0.36858	0.34419
Tyrosine	0.27359	0.27359	0.22032
Phenylalanine	0.18666	0.20153	0.18104
Unknown	0.10624	0.07864	0.08720
	4.65412	4.70691	4.34367
Recovery %	96.35%	97.44%	89.92%

Table 2. Numbers of Amino Acid Residues per Molecular Weight=60,-000 G-Actin

Amino Acid	12 hr hydrolysis	24 hr hydrolysis	72 hr hydrolysis
Lysine	23.4758	26.0842	25.3389
Histidine	8.4463	10.5579	9.9368
Ammonia	63.8443	58.7516	50.3053
Arginine	19.1284	20.2463	19.3768
Aspartic Acid	43.5979	43.9706	41.5360
Threonine	32.7916	31.4253	27.5251
Serine	25.8358	23.9726	18.1844
Glutamic Acid	53.7832	56.6400	49.9824
Proline	22.6063	21.7368	20.7680
Glycine	36.5179	36.0211	35.7790
Alanine	39.7474	38.2569	36.4682
Half-cystine	5.4652	4.2231	3.2791
Valine	22.1095	24.7179	25.2396
Methionine	7.9494	6.8315	6.0614
Isoleucine	27.6989	28.9411	29.7112
Leucine	33.1642	34.9032	32.5928
Tyrosine	18.7558	18.7558	15.1040
Phenylalanine	14.0358	15.1537	13.6134
Unknown	9.5642	7.0800	7.8501

Table 3. Amino Acid Composition of Bovine G-Actin

Amino Acid	Residues[1] per molecule[2]	gm per molecule[2]	Residue % (moles)	Weight % (gm)
Lysine	26.0842	3055.7640	5.13	5.12
Histidine	10.5579	1638.1637	2.08	2.75
Ammonia	49.8034[3]	847.2408	9.80	1.42
Arginine	20.2463	3527.1079	3.98	5.92
Aspartic Acid	43.9706	5852.4868	8.65	9.82
Threonine	34.1579[4]	4068.2058	6.72	6.82
Serine	27.6990[4]	2910.3879	5.45	4.88
Glutamic Acid	56.6400	8333.4432	11.14	13.93
Proline	21.7368	2502.5577	4.28	4.20
Glycine	36.0211	2704.1039	7.09	4.53
Alanine	38.2569	3508.3072	7.53	5.72
Half-cystine	6.7073[4]	1611.6971	1.32	2.70
Valine	24.7179	2895.7019	4.86	4.86
Methionine	6.8315	1019.3281	1.34	1.71
Isoleucine	28.9411	3796.2040	5.69	6.37
Leucine	34.0932	4573.2527	6.87	7.68
Tyrosine	18.7558	3398.3634	3.69	5.70
Phenylalanine	15.1537	2503.2397	2.98	4.20
Unknown	7.0800	976.8984	1.39	1.64
	508.2696	59627.4541		

[1] Values taken at 24 hours hydrolysis.
[2] Assumes M. Wr. of 60,000.
[3] The value for ammonia was obtained by subtracting losses in serine, threonine, and half-cystine after 24 hours hydrolysis, from the ammonia value at 24 hours.
[4] Extrapolated value.

from its amino acid composition. Assuming one mole of methionine per mole of protein, a value of 8,782.7 is attained. If 7 methionine residues were present per molecule of G-actin, the molecular weight would be about 61,479. If molecular weight is computed in terms of tyrosine residues, the result is about 60,781. Partially supported by Market Quality Research Division, ARS, USDA, Cooperative Agreement 12-14-100-9348 (51).

Swine

Selection For Crossing Ability In Swine

I. T. Omtvedt

The basic objective of Project 808 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 cannot 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 boars and gilts for breeding on the basis of their Duroc-Beltsville crossbred half-sisters' productivity (litter size and 21-day weight).

The project is currently in the sixth generation of selection. Productivity of the crossbreds has been very desirable but continual improvement in the crossbreds over the controls each generation is not readily apparent at this time. This procedure is widely used in plant breeding and research with laboratory organisms indicated that it may have application in swine breeding, but results to date are not very encouraging. This project will be phased out at the end of sixth generation.

The project is currently in the sixth and final generation of selection. The productivity of the Duroc-Beltsville No. 1 crossbred gilts compared to the productivity of the control line gilts will be used to evaluate the effectiveness of selection for crossing ability. An analysis of the control line data from 1961 to 1970 showed that performance and productivity