Meat and Carcass Evaluation

The Relation of K^{40} Net Count and Probe to Body Composition Changes in Growing and Fattening Swine

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Story in Brief

This research was initiated to study the feasibility of using the K^{40} technique and live backfat probe to evaluate body composition changes in muscling in swine at different slaughter weights. A new K^{40} detector arrangement was used in this study in an attempt to improve counting efficiency for hogs ranging in weight from 100 to 300 pounds. The Duncan Lean Meter was used as the live backfat probe in the study.

One hundred barrows involving ten replications of ten feeder pigs each were randomly allotted to slaughter weight groups of 100, 150, 200, 250, and 300 pounds. From each replication, two pigs were randomly assigned to each slaughter weight group, making a total of 20 pigs (14 Hampshires and 6 Yorkshires) for each of five slaughter weights. Upon reaching the pre-determined slaughter weight, each pig was evaluated using the K^{40} technique and live backfat probe (Duncan Lean Meter) and transported to the O.S.U. Meat Laboratory for slaughter and carcass evaluation. Carcass measurements obtained included length, average backfat thickness, loin eye area, weight of ham, loin, and shoulder, weight of total fat trim, bone weight, and weight of boneless closely trimmed lean from the right carcass half. Ether-extract analyses were conducted on ground lean samples of the right carcass halves and total pounds of fat-free lean were determined.

The data yield very good estimates of the changes in measurements, counts and composition of the barrows as they developed from 100 to 300 pounds. It is also apparent that these were very muscular barrows that continued to grow more and fatten less than is typical of barrows generally after reaching usual market weights of about 225 pounds.

Five prediction equations involving live weight, K^{40} count, and live backfat probe as predictors were developed to estimate pounds of fat-free lean which accounted for from 98.1 to 77.6 percent of the variation in pounds of fat-free lean in the Yorkshires and from 96.3 to 77.9 percent in Hampshires, respectively. Live weight alone was associated with 96 percent of the variation in pounds of fat-free lean in the Yorkshires and 94.4 percent of the variation in the Hampshires. While the addition of net K^{40} count to the equation improved the predictive value of the equation, such improvement was relatively small.

Introduction

The search for an accurate method of estimating the composition of meat animals has resulted in the development and evaluation of various instruments designed for this purpose. Early attempts to estimate carcass composition generally consisted of the analysis of a small portion of the carcass such as loin eye area, certain bone and muscle relationships, or the actual physical dissection of the carcass, or a portion of its parts. Some of these methods are quite reliable predictors of carcass composition, but all were laborious, costly and require the slaughtering of animals. In more recent years, researchers have sought for more efficient ways of estimating body composition that would not require the sacrificing of animals. Two such methods that have been evaluated at the Oklahoma Agricultural Experiment Station are the O.S.U. K^{40} whole-body counter and the Duncan Lean Meter live backfat probe.

Previous research at the Oklahoma Station involving these two methods of evaluation were conducted using barrows that were uniform in age, breeding and weight. Results from these studies, primarily involving the K^{40} whole-body counter, have led to the development of prediction equations that are currently used to predict the muscle content of 220-240 pounds hogs.

The feasibility of using the K^{40} technique and live probe to predict muscling in younger, lighter weight hogs has been considered with the thought that considerable savings in time and expense could be achieved if prediction equations were available for such animals.

Materials and Methods

One hundred market barrows (70 Hampshires and 30 Yorkshires) were evaluated by the K^{40} whole-body counter and a live probe (Duncan Lean Meter) beginning in March, 1972, and ending in January, 1974. The barrows were obtained from the University purebred herds, weighing between 60 and 70 pounds each and were generally large framed, growthy, heavily muscled pigs.

Ten replications, each consisting of ten feeder pigs, were randomly assigned to slaughter weight groups of 100, 150, 200, 250, and 300 pounds and placed on a growing-fattening ration. From each replication, two pigs were randomly allotted to each slaughter weight group, making a total of 20 pigs in each of the five slaughter groups as shown in Table 1.

As the pigs reached the shrunk live weights of 100, 150, 200, 250, and 300 pounds, they were taken off-feed for 24 hours and thoroughly washed to remove any foreign materials that might influence the K^{40} count. The pigs were then probed at the first rib, last rib, and last lumbar vertebra with a Duncan Lean Meter.

The Duncan Lean Meter provided a rapid method for estimating the thickness of backfat. The method is based on the differences in electrical conductivity of fat and muscle; fat being a relatively poor conductor, while muscle is considered to be a good conductor by comparison.

After the pigs were probed, they were K^{40} counted in a randomized order. A new detector arrangement was used in counting these animals in an attempt to improve K^{40} counting efficiency over a range of live weights (100 to 300 pounds). In addition to a new detector arrangement, a method of positioning the pigs as close to the detector system as possible was devised. Those pigs in the light weight groups were evaluated in the counting chamber by placing one or more one-inch planks on the floor of the chamber in order to maintain the same distance between animals of different weights and the detectors.

Each barrow was evaluated twice on the same day by the K^{40} whole-body counter. This was done in an effort to determine the repeatability of the instrument. Correlation coefficients between the first and second net K^{40} counts are presented in Table 2. Values at each weight were found to be highly significant, indicating that the instrument was repeating itself reasonably well. The repeatability was not as high for the 100 pound weight groups as for the heavier weights.

Table 1. Experimental Design

Replication	Slaugher Weight Groups (pounds)				
	100	150	200	250	300
I	2[1]	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.

Table 2. Correlation Coefficients Between First and Second Live K^{40} Net Counts (same animal)

	Slaughter Weight Groups (pounds)				
	100	150	200	250	300
No. of Animals	100	80	60	40	20
Correlation Coefficients	0.80**	0.92**	0.92**	0.95**	0.92**

Those barrows designated at the beginning of the experiment to be slaughtered at a particular weight were transported to the O.S.U. Meat Laboratory for slaughter and carcass composition evaluation. The carcass measurements obtained included length, average backfat thickness, loin eye area, weight of ham, loin, shoulder, total fat trim, bone, and weight of boneless closely trimmed lean from the right carcass half.

Chemical analyses for ether-extract were conducted in triplicate on samples representing the boneless, closely trimmed muscle mass from the right half of each carcass. Ether extraction was determined by a standard A.O.A.C. method. Fat-free lean was determined by subtracting total ether-extractable materials from the weight of the boneless, closely trimmed muscle mass from the right carcass half. This method has been shown to produce a very accurate measure of carcass leanness.

Results and Discussion

The data in Table 3 are presented as a description of the barrows from a carcass measurement and composition standpoint. Later reference will be made regarding the desirability of this set of barrows insofar as growth characteristics and muscling are concerned. Figure 1 is a graphic presentation of the rate of muscle growth by slaughter weight groups as determined by differences in amounts of fat-free lean between slaughter weights. It can be seen from this tabulation of the composition data that bone increased at a steady rate from 100 pounds through 300 pounds live weight. Fat tended to increase at a more rapid rate through the heavier weights, but at a distinctively slower rate than is generally found in market hogs, especially in weights above 200 pounds. Lean, on the other hand, normally increases at a much slower rate beyond 200 pounds live weight than was characteristic of these growthy and very meaty barrows, that continued to produce muscle at a faster rate than normal even up to 300 pounds live weight.

Means for K^{40} counts per minute and live probe for both Yorkshire

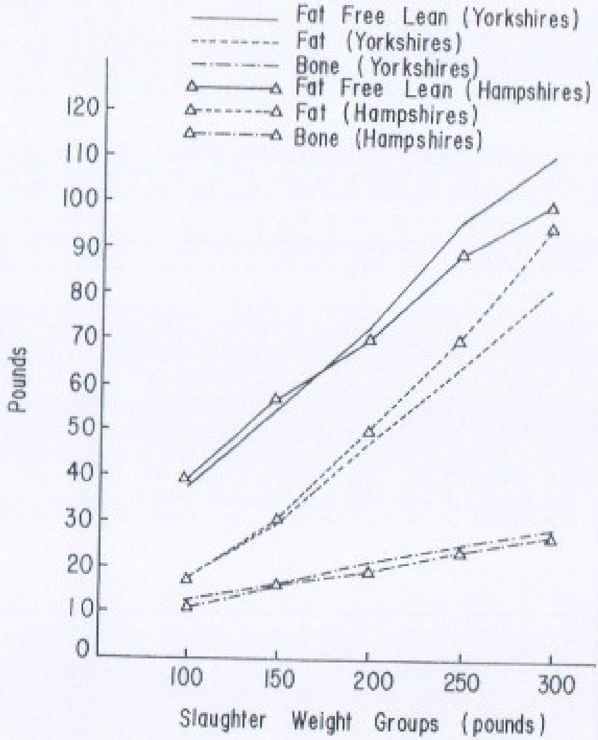

Figure 1. Mean pounds of fat-free lean, fat, and bone from Yorkshire and Hampshire barrows at five different weights.

and Hampshire pigs slaughtered at different weights are shown in Table 4.

As slaughter weight increased, net K^{40} count per minute increased for both breeds. The realtionship between net K^{40} count and slaughter weight is more clearly illustrated in Figure 2. A rather steady increase was observed for mean K^{40} counts per minute for the Yorkshires from 100 to 250 pounds with a slight decline in rate of increase occurring from 250 to 300 pounds. It appears that the steady increase for mean K^{40} count did not exist in the Hampshire data as in the Yorkshire data, especially from 250 to 300 pounds were only a moderate increase in K^{40} count was observed. The differences in net K^{40} count responses (especially from 250 to 300 pounds) indicate that there may have been some composition differences between the Hampshire and Yorkshire pigs representing the 300 pound slaughter group. While pounds of fat-free lean for the 100, 150 and 200 pound barrows were quite comparable in both breed groups,—

Table 3. Mean Carcass Measurements of Barrows at Different Weights

YORKSHIRES	Slaughter Weight Groups (pounds)				
	100	150	200	250	300
Number of animals	6	6	6	6	6
Carcass weight, Lbs.	68.0	103.0	141.7	187.0	222.9
Dressing percent	67.4	69.2	72.4	74.1	74.3
Backfat, in.	0.62	0.93	1.14	1.26	1.28
Carcass length, in.	25.3	28.2	30.5	32.4	34.3
Loin eye area, sq. in.	2.62	3.75	4.49	5.35	6.18
Lean cuts, % car. wt.	62.6	61.1	58.7	59.0	57.3
Fat-free lean, lbs.	38.0	55.1	72.7	96.1	110.8
HAMPSHIRES					
Number of animals	14	14	14	14	14
Carcass weight, lbs.	68.5	104.4	141.0	184.6	223.2
Dressing percent	67.3	70.5	71.7	74.5	74.5
Backfat, in.	0.62	0.80	1.05	1.19	1.41
Carcass length, in.	24.8	27.8	29.7	31.7	33.2
Loin eye area, sq. in.	3.14	4.30	5.02	5.83	5.77
Lean cuts, % car. wt.	64.8	63.3	58.5	57.6	53.5
Fat-free lean, lbs.	39.2	56.9	70.2	89.2	100.5

Table 4. Mean Live Measurements For Yorkshire and Hampshire Barrows Slaughtered in Different Weights.

	Slaughter Weight Groups (pounds)				
	100	150	200	250	300
YORKSHIRES (No.)	6	6	6	6	6
Slaughter wt., (lbs.)	100.8	148.7	195.8	252.2	300.2
K^{40} C.P.M., live	3641	4559	5253	6007	6494
Live Probe, in.	0.59	0.90	1.08	1.27	1.36
HAMPSHIRES (No.)	14	14	14	14	14
Slaughter wt., lbs.	101.7	148.1	196.8	247.7	299.6
K^{40} C.P.M., live	3747	4887	5187	6050	6171
Live Probe, in.	0.61	0.81	1.10	1.24	1.43

the 250 pound Yorkshires had 7 pounds more fat-free lean and at 300 pounds—over 10 pounds more (about 10 percent) fat-free lean than the Hampshire barrows (see Table 3).

As illustrated in Figure 2., the most rapid increase in net K^{40} count per minute for both breeds occurred between the 100 and 150 pound weights, while the slowest rate of increase in K^{40} net count occurred between the 250 and 300 pound weight interval for both breeds. The somewhat smaller increase in net K^{40} count from 250 to 300 pounds may have been due to the possible "shielding" effect of fat against the transmission

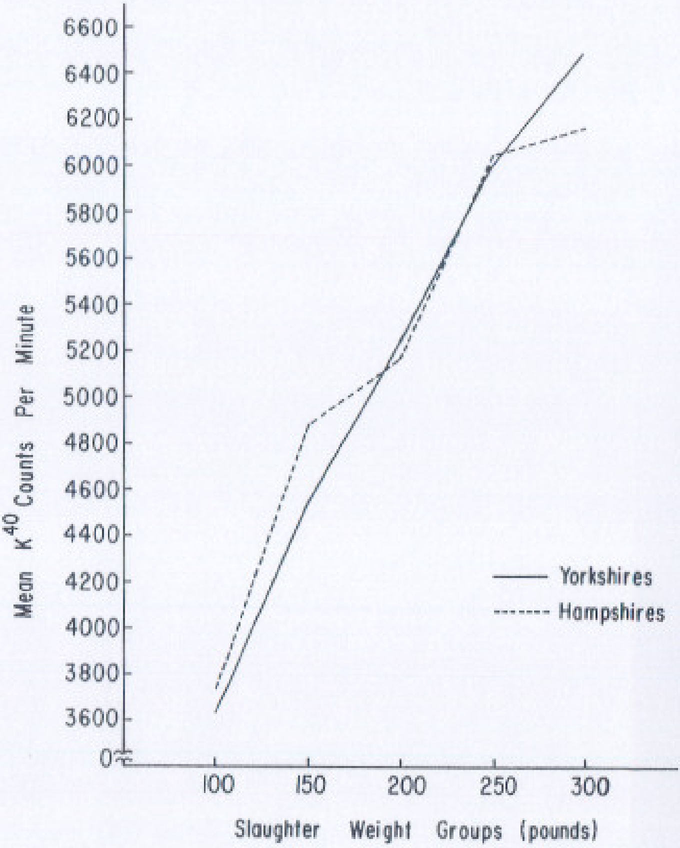

Figure 2. Mean K^{40} Counts per minute for Yorkshire and Hampshire barrows slaughtered at different weights.

of radiation energy from whole-body potassium which has been postulated by researchers in this field.

The average backfat thickness estimated by the live probe ranged from 0.59 to 1.36 inches for the Yorkshires and from 0.61 to 1.43 inches for the Hampshires (Table 4). Average increases in backfat probe for each 50 pound increase in live weight were 0.31, 0.18, 0.19, 0.09 inches for the Yorkshires and 0.20, 0.29, 0.14, and 0.19 inchs for the Hampshires. The increase in backfat probe with increased live weight was rather uniform in the Hampshire data. However, this was not the case in the Yorkshire data where the greatest increase in live probe occurred from 50 to 100 pounds, while the smallest increase occurred from 250 to 300 pounds.

One of the primary objectives in this study was that of the development of prediction equations for estimating pounds of fat-free lean in barrows weighing 100 and 300 pounds. Three live measurements (live weight, K^{40} count, and live probe) were made on each barrow prior to slaughter. A regression study was conducted on these estimates in an effort to determine their relationships with each other, as well as with fat-free lean, and to establish some prediction equations which would prove useful in estimating fat-free lean in pigs weighing between 100 and 300 pounds.

Linear prediction equations for fat-free lean are presented in Table 5 for the Yorkshires and Hampshires. Standard errors of estimate and coefficients of determination are also given for each regression equation. The standard error of estimate is the average amount by which one would miss the trait (pounds of fat-free lean) being predicted if he used the prediction equation indicated. In these data where the barrows were of five distinct weight groups, the use of weight as the only predictor was better than using either K^{40} count or live probe. The use of K^{40} count in combination with live weight predicted a little more accurately than using live probe with live weight (average miss of 3.9 vs. 5.3 or 4.5 vs. 5.4 lbs.)

When the data were studied within the weight groups to determine

Table 5. Linear Prediction Equations for Yorkshire and Hampshire Pigs Using K^{40} Count, Live Weight, and Live Probe

	Predicted Variable		Weight	K^{40} Count	Live Probe	Standard Error of Estimate[2]
YORKSHIRES	(30)					
	FFL[1]	−106.4	+2.98(WT)			5.67
	FFL	248.2		−0.20(CT)		8.71
	FFL	234.5			−838.99 (L.P.)	13.99
	FFL	− 20.0	+0.25(WT)	+0.009(CT)		3.92
	FFL	4.2	+0.43(WT)		− 13.96 (L.P.)	5.29
HAMPSHIRES	(70)					
	FFL	−138.8	+3.72(WT)			5.55
	FFL	−568.1		+0.49(CT)		8.33
	FFL	50.5			−141.57 (L.P.)	11.04
	FFL	− 12.5	+0.22(WT)	+0.008(CT)		4.46
	FFL	13.1	+0.39(WT)		− 18.29 (L.P.)	5.41

[1] FFL=Predicted pounds of fat-free lean.
[2] Average amount by which predicted value would be expected to miss the actual pounds of fat-free lean.

how well fat-free lean could be predicted on that basis from K^{40} count and/or live probe, it was found that the results were too inconsistent for interpretation. This was due to small numbers in each breed at each weight and to the lower relationships between K^{40} count and live probe with carcass composition measures when the barrows were essentially of the same size.

The value of an insturment such as the K^{40} whole-body counter or Duncan Lean Meter depends upon its ability to improve the accuracy with which we make predictions. Results of this study indicated that live weight alone removed 96.3 percent of the variation when predicting fat-free lean in the Yorkshires and 94.4 percent of the variation in the Hampshires. When K^{40} count was placed in the regression equation, 91.3 percent of the variation in predicting fat-free lean was accounted for in the Yorkshires, while the value was 87.4 percent in the Hampshires. The live backfat probe estimate contributed the least insofar as removing variation in estimating fat-free lean (77.6 percent in the Yorkshires and 77.9 percent in the Hampshires).

The prediction value of "live weight" for muscling in very muscular hogs that are continuing to develop muscling at a rapid rate at what to some may appear to be a "heavy" weight (300#) is not totally unexpected. Figure 2 illustrates the point that both the Yorkshire and Hampshire barrows had only very slightly retarded their rate of fat-free lean development at 300 pounds. As muscle storage diminishes and body fat stores accumulate, which is characteristic with meat animals on feed as they reach mature body weight, then body weight is expected to become of lesser value as a predictor of fat-free lean in the body.
