Meat and Carcass Evaluation

Evaluation of Live Animal K^{40} Count as A Predictor of Lean in Beef Bulls*

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Story in Brief

Forty yearling Angus bulls were counted in the potassium-40 (K^{40}) whole body counter at the OSU Live Animal Evaluation Center during the spring of 1969 for the purpose of evaluating live K^{40} count as a predictor of total muscle in beef bulls. The 40 bulls were alloted to four different weight groups following a 160 day feedlot performance test and were processed through the evaluation center during four successive weeks with the heaviest group being evaluated first. Two 10-minute counts were obtained on each animal after 24, 48 and 72 hours of shrink, respectively. Following slaughter, the right side of each carcass was separated into lean, fat and bone. The separable lean was analyzed for ether extract content in order to determine the total quantity of fat free lean for each animal.

The estimates of repeatability between two counts taken on the same animal on the same day were 0.94, 0.89 and 0.96 following 24, 48 and 72 hours of shrink, respectively, which indicates the K^{40} counter was able to repeat measurements reasonably well in this group of bulls.

The correlation coefficients pooled over groups between the average of two K^{40} counts taken on the same day and pounds of fat free lean were 0.87, 0.83 and 0.87 following 24, 48 and 72 hours of shrink, respectively, compared with a correlation of 0.87 between the average of all six counts and fat free lean. The best overall estimate of the correlation between K^{40} count and fat free lean was 0.87 and there was no evidence that shrinking animals beyond 24 hours was necessary.

A linear relationship was found to exist between K^{40} count and fat free lean and 74 percent of the variation in fat free lean was associated with variation in K^{40} count. A prediction equation for fat free lean

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based on average K^{40} count had a standard error of estimate of 8.4 lbs. which is the difference btween predicted and actual measured amounts of fat free lean for an animal on the average. A prediction equation utilizing both average weight and K^{40} count was no more accurate in predicting fat free lean than the one using K^{40} count alone.

These data suggest K^{40} count could be useful in conjunction with other performance data in selecting yearling bulls that have superior genotypes for rapid growth of muscle.

Introduction

As the breeding programs of the beef cattle industry place increased emphasis on muscling in beef carcasses, it is apparent that a need exists to develop accurate methods of estimating lean content of the live animal. Current procedures for determining the breeding value of prospective herd sires with respect to carcass characteristics by slaughtering a random sample of their progeny and/or sibs are costly and time consuming. The development of accurate techniques for determining carcass merit of the live animal will make it possible to effectively select breeding cattle that are genetically superior for desirable carcass characteristics.

The potassium-40 (K^{40}) whole body counter is being tested at the OSU Live Animal Evaluation Center for its effectiveness in detecting quantity of lean in the live animal. The whole body counter counts the emission of gamma rays from a radioactive isotope of potassium, K^{40}, which occurs naturally in the live animal. The basic principle of this technique is predicated on the fact that K^{40} constitutes a relatively fixed proportion of the total potassium in the body and since the majority of the potassium is located in lean muscle, the supposition is made that differences in K^{40} count among animals would be estimating primarily differences in quantity of lean tissue.

The purpose of this study was to evaluate live K^{40} count as a predictor of total lean in yearling beef bulls.

Materials and Methods

Forty Angus bulls of approximately one year of age were evaluated by the K^{40} counter during the spring of 1969. The 40 bulls were selected to be as similar in live weight as possible at the completion of a 160 day feedlot weight, the animals were allotted to four groups with the heaviest 10 bulls assigned to group 1, the next heaviest 10 to group II, the third heaviest 10 to group III and the lightest 10 to group IV. The four groups were processed through the OSU Live Animal Evaluation

Center during the next four successive weeks in sequence with the heav-group being evaluated first. Bulls in the latter groups remained in the feedlot until it was time for their respective groups to be evaluated.

The same procedures were followed in evaluating each of the four groups of bulls. At 7:00 a.m. on Monday the ten bulls to be evaluated that week were taken off feed, trucked to Stillwater, tranquilized and washed thoroughly with soap and water. Tuesday morning the 10 bulls were counted in a random order. At the time of the first K^{40} count all bulls in that group had been off feed at least 24 hours. Tuesday afternoon the ten bulls were counted again in another random sequence. This procedure was repeated on Wednesday and again on Thursday. Thus, every bull had a total of six K^{40} counts, two following a 24 hour shrink, two following a 48 hour shrink and two following a 72 hour shrink. Each count recorded was the average counts per minute obtained from a 10 minute count. A background count of the empty chamber was taken just prior to placing an animal in the chamber and again immediately after removal. The net K^{40} count accredited to an animal was the difference between the count with the animal in the chamber and the average of the two background counts.

After the final count the bulls were fed and transported to a commercial packing plant for slaughter. The carcasses were returned to the OSU Meats Laboratory and the right side of each carcass was separated into bone, fat and lean. The closely trimmed, boneless lean was carefully ground and mixed and samples obtained which were analyzed for ether extract content in order to determine the total quantity of fat free lean for each carcass.

Results and Discussion

Table 1 presents the weight distribution of the four groups of animals after a 24 hour shrink just prior to their first K^{40} count and the average fat free lean for each group. Average weight gradually declined with each successive group. Animals were similar in weight within

Table 1. Population Description Showing Live Weight After a 24-Hour Shrink and Amount of Fat Free Lean

Group	Bulls	Wt. (lbs.)	Wt. Range (lbs.)	Avg. Wt. FFL (lbs.)
I	10	884	869-908	294
II	10	854	833-882	294
III	10	828	807-855	294
IV	10	826	788-842	305
Total	40	848	788-908	297

each group with an average weight range of 48 lbs. Individual weights overlap between groups because each succeeding group spent an additional week in the feedlot prior to being evaluated. The average weight of the 40 bulls was 848 pounds with individual weights ranging from 788 to 908 pounds. Although live weight gradually declined with each succeeding group, the amount of fat free lean was relatively constant with the lightest group, group IV, in fact having the heaviest average fat free lean.

In order for the K^{40} counter to be very useful it must be able to make precise determinations of K^{40} count, and the measured K^{40} count must provide an accurate estimate of the lean content of an animal. The capability of the K^{40} counter to repeat its measurements was determined as the correlation between two counts taken on the same animal on the same day. Repeatability estimates are presented in Table 2 for each group during each of the three shrink periods. The correlation coefficients computed for each group and day ranged from 0.79 to 0.99 which were quite consistent for correlations based on only 10 observations. The correlations pooled within groups for each day ranged from 0.89 to 0.96 with an average value of 0.93. There was little variation in the ability of the K^{40} counter to repeat its measurements from one group of animals to the next, consequently, the repeatability estimates based on the total group of 40 bulls were essentially the same as the pooled within group estimates. There was no evidence that the degree of body fill after the initial 24 hour shrink had any influence on the ability of the counter to repeat its measurements.

One method of evaluating the usefulness of K^{40} count as an indicator of lean content is to determine correlation coefficients between K^{40} count and pounds of fat free lean. The higher the correlation between these two variables, the more effective K^{40} count will be in detecting differences in quantity of lean among animals. Table 3 presents correlation coefficients between K^{40} count and pounds of fat free lean for each day. Correlations were computed within each group for individual

Table 2. Repeatability of K^{40} Counts Measured on the Same Animal on the Same Day Following 24, 48 and 72 Hours of Shrink

Group	No.	Shrink Periods		
		24 Hour	48 Hour	72 Hour
I	10	0.90	0.79	0.95
II	10	0.95	0.97	0.99
III	10	0.96	0.97	0.96
IV	10	0.96	0.83	0.94
Pooled	40	0.94	0.89	0.96
Total	40	0.93	0.90	0.94

Table 3. Correlations Between K^{40} Count and Pounds of Fat Free Lean for Each Shrink Period and the Average of All Six Counts

Group	No. Bulls	24 Hour Shrink			48 Hour Shrink			72 Hour Shrink			Avg. All 6 CTS
		CT 1	CT 2	AVG 2 CTS	CT 3	CT 4	AVG 2 CTS	CT 5	CT 6	AVG 2 CTS	
I	10	0.86	0.70	0.80	0.58	0.62	0.64	0.75	0.86	0.82	0.78
II	10	0.88	0.79	0.84	0.89	0.83	0.87	0.84	0.82	0.83	0.87
III	10	0.91	0.89	0.91	0.93	0.93	0.94	0.94	0.93	0.94	0.94
IV	10	0.87	0.92	0.90	0.91	0.78	0.89	0.85	0.83	0.86	0.89
Pooled	40	0.88	0.83	0.87	0.82	0.79	0.83	0.85	0.87	0.87	0.87
Total	40	0.87	0.82	0.86	0.82	0.80	0.83	0.84	0.82	0.86	0.86

counts, the average of two counts measured the same day and the average of all six counts. Correlations for the entire group were computed by pooling the within group correlations over groups and also by treating the forty bulls as a single group of forty animals. Following a 24 hour shrink the within group correlations between individual counts and fat free lean ranged from 0.70 to 0.92. Considerable variation in correlation coefficients is normally expected when only ten observations are involved. Consequently, more reliable estimates of the true associations between K^{40} count and fat free lean are provided by pooling data over groups. Pooled correlations were 0.88 and 0.83 for counts 1 and 2, respectively, and 0.87 for the average of the two counts. Similar patterns of variation were observed for the within group correlations obtained following 48 and 72 hours of shrink, and the pooled correlations for the average of two counts were 0.83 and 0.87 for those two days, respectively. The best overall estimate of the association between K^{40} count and fat free lean is the correlation based on the average of all six counts pooled over groups which was found to be 0.87. In all cases the correlations computed on a total group basis were very similar to the pooled correlations which supports the development of a single prediction equation for fat free lean based on K^{40} count that would be applicable to the entire group of 40 bulls.

If the failure of K^{40} count to accurately detect fat free lean was due to random errors, the correlations based on the average of two counts, which represents a total of 20 minutes counting time, should be higher than with individual counts, which represent average counts per minute based on 10 minutes of counting time. Such an increase in correlation was not observed with these data. The correlations based on the average of two counts were generally intermediate between those obtained for the two counts separately. Similarly, an increase should be obtained for correlations based on the average of all six counts if random errors of measurement were involved. Correlations between the average of six counts and fat free lean were generally no higher than the correlations obtained for each day separately, which suggests that the errors of measurement were not random errors, but rather an inherent failure of the K^{40} counter to be completely accurate in detecting differences in lean content among animals. This may be partly due at least to the contribution of hide and offal to the total K^{40} count of the live animal.

The average K^{40} count and measured amount of fat free lean for each of the 40 bulls is shown in Figure 1. Each dot on the graph represents one of the bulls. The fat free lean for a particular bull can be determined from the vertical axis and the average K^{40} count can be determined from the horizontal axis. The straight line running through the dots is the regression line of fat free lean on K^{40} count and represents the prediction equation of fat free lean based upon K^{40} count. To determine the predicted amount of fat free lean from this graph locate the average K^{40} count of that animal on the horizontal scale, go upward in a perpendicular line to the regression line and go across in a perpendicular line to the vertical axis and read the predicted fat free lean from the vertical scale. The value obtained is exactly equal to that obtained by computing fat free lean from the prediction equation: $\hat{Y}$ = predicted pounds of fat free lean = 75.5 + (0.0145). X (K^{40} count). It is clear from

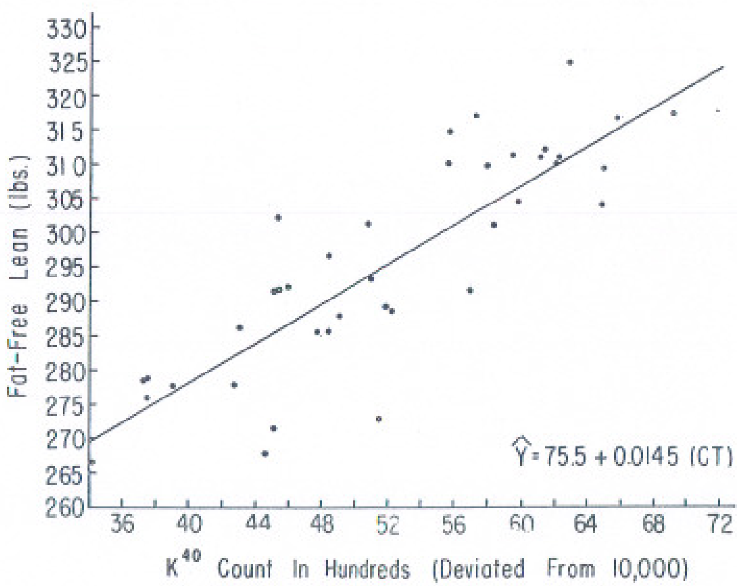

Figure 1. Graph of Fat Free Lean and Average K^{40} Count for Forty Yearling Angus Bulls and the Regression Line of Fat Free Lean on K^{40} Count.

Figure 1 that a definite linear relationship exists between fat free lean and K^{40} count. On the average the predicted values (points on the regression line) were fairly close to actual values, however, there were individual cases where the predicted fat free lean differed from actual amounts by as much as 19 lbs. The standard error of estimate associated with this prediction equation was 8.4 pounds which is the amount by which the predicted and actual amounts of fat free lean differed on the average. In other words, the average miss from using this prediction equation was 8.4 pounds in these 40 bulls.

Table 4 presents several prediction equations for fat free lean, standard errors of estimate for each equation and multiple correlation coefficients between each prediction equation and fat free lean. Information in this table provides some evidence concerning the relative merit of live K^{40} count for detecting differences in quantity of muscle among animals. The higher the multiple correlation, the stronger the association between the prediction equation and amount of fat free lean and the smaller the standard error of estimate, the more accurate the prediction equation was in predicting pounds of fat free lean. The average amount of fat free lean in this group of 40 bulls was 297 pounds and if every bull was estimated to have this average amount, the average miss would be 16.4 pounds. A relatively low relationship existed between live weight and fat free lean in this group of bulls, consequently, a prediction equation based on live weight was of little value and reduced the average miss only slightly to 16.0 pounds. This was not unexpected for this group of bulls since they were initially selected to be as similar in live weight as possible. Live weight would be expected to have a stronger association with lean content on a random group of bulls that exhibited more variation in weight. K^{40} count had a close association with fat free lean and the prediction equation based on count alone was considerable more accurate in predicting fat free lean as indicated by an average miss of 8.4 pounds. A prediction equation utilizing both weight and count was no more accurate in predicting fat free lean than the one utilizing count alone.

Table 4. Prediction Equations for Pounds of Fat Free Lean, Multiple Correlations and Standard Errors of Estimate

Prediction Equation (Pounds FFL = $\hat{Y}$)	Multiple Correlation	Standard Error of Estimate (lbs.)
$\hat{Y}$ = Average FFL = 297 lb.	----	16.4
$\hat{Y}$ = 425.4 — 0.1556 (WT)	0.26	16.0
$\hat{Y}$ = 75.5 + 0.0145 (CT)	0.86	8.4
$\hat{Y}$ = 96.1 — 0.023 (WT) + 0.0144 (CT)	0.86	8.5

SUMMARY

Results from this study indicate that a definite linear relationship exists between K^{40} count and quantity of muscle, consequently, the K^{40} counter could be useful in conjunction with other performance data in selecting yearling bulls that have superior genetic potential for rapid growth of muscle. It should be emphasized that these bulls were very similar in weight and breeding and, consequently, the prediction equation developed from these bulls would probably not be generally applicable to other animals.