January 1973

RELATIONSHIP BETWEEN WEIGHT AND ^{40}K COUNT IN STEERS

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Summary

THIRTY-SIX Angus-Hereford steers were fed four diets of different potassium concentration for 2-week periods such that each steer received each diet for a 2-week period. The relationship between ^{40}K count loss and weight loss during a 24-hr. shrink period was evaluated by regression analysis. At the end of each of the four feeding periods the steers were weighed and ^{40}K counted unshrunk and again after 24-hr. shrink.

The mean weight loss during shrink was similar for all treatments (overall mean of 22.8 kg), however the mean ^{40}K count loss was larger for the high potassium diets than for low potassium diets although the rank of these means did not correspond to the potassium content of the diets. The overall loss in ^{40}K count during shrink was 708.3 (S.D.= 449.2) counts per minute. The regression coefficients of count loss on weight loss during shrink were not significantly different among treatments. The pooled regression coefficient was 22.5$\pm$5.4 cpm per kilogram.

When ^{40}K count was regressed on weight, all regression coefficients were significantly ($P<.01$) greater than zero, however regression coefficients for the various treatements were not significantly different from each other, although there was a tendency for coefficients to be higher for high potassium diets and on unshrunk measurements. Pooled unshrunk and shrunk regression coefficients of ^{40}K count on weight were 14.75$\pm$1.92 and 12.41$\pm$1.76 cpm per kilogram, respectively.

Introduction

Several studies utilizing net ^{40}K count to estimate fat-free lean in beef cattle have been reported (McLellan, 1969; Frahm, Walters and McLellan, 1971; Lohman *et al.*, 1966). The animals used in these studies were treated as similarly as possible prior to being ^{40}K counted. Similar diets were fed to all animals, with the exception of Lohman *et al.* (1966), who fed two diets differing in radioactivity. The animals were counted and slaughtered at a predetermined weight and attempts were made to control radioactivity of gastro-intestinal contents by subjecting animals to a standard shrinkage period prior to whole-body counting.

Present methods of ^{40}K evaluation frequently involve trucking animals for some distance and then shrinking prior to counting. Consequently, fat-free lean prediction equations developed with animals subjected to standard conditions are being used to estimate fat-free lean in animals of different weights which have received different diets and that differ in the amount and composition of the gastro-intestinal contents. Unpublished data from this station indicates that as animals lose weight their ^{40}K count decreases.

This paper presents the results of a study of the relationship between ^{40}K count and weight and ^{40}K count loss and weight loss during shrink as affected by diet.

Materials and Methods

The data for this study were obtained from 36 Angus-Hereford crossbred steers fed a standard diet followed by three different diets and weighed and ^{40}K counted twice (unshrunk and after a 24-hr. shrinkage period) every 2 weeks during the experiment. The experimental procedures for the trial have previously been reported (Johnson, Walters and Whiteman, 1972).

The experiment included a 2-week standardization period followed by three 2-week feeding periods during which each steer received a different diet in each period. The diets were a high potassium diet, diet A, composed of alfalfa and corn; a high potassium diet, diet B, with added KCl as the major potassium

[1] Journal Article No. 2400 of the Oklahoma Argicultural Experiment Station, Department of Animal Sciences and Industry, Stillwater.

TABLE 1. MEAN WEIGHTS AND STANDARD DEVIATIONS FOR STEERS FED THE VARIOUS DIETS

Diet	Unshrunk steer weight, kg		Shrunk steer weight, kg	
	Mean	SD	Mean	SD
A	410.0	39.2	386.7	36.2
B	416.1	40.9	392.8	38.3
C	418.6	46.6	395.3	41.7
D	393.7	40.8	371.1	30.5

source; a low potassium diet, diet C, consisting of wheat straw and corn; and the standardization diet, diet D, consisting of equal parts of diets A and C. Diet B was prepared by adding 772g KCl to each 45.4 kg of diet C. Average potassium concentrations of diets A, B, C and D were 1.31%, 1.03%, 0.29% and 0.80%, respectively.

All steers were fed diet D during the first 2-week period. At the end of this period, the steers were randomly assigned to a row of one of 12 3 X 3 latin squares where columns of the squares were 2-week feeding periods and treatments were diets A, B and C. As a result, in feeding periods 2, 3 and 4, 12 steers received each of diets A, B and C and at the completion of the study each steer had received each diet for a 2-week period.

At the end of every period weights and ^{40}K counts were taken on each steer. These measurements were made while steers were still on feed and water (unshrunk) and after being held off feed and water for 24 hr. (shrunk). Shrunk measurements began 24 hr. after feed and water had been removed and were completed 6 hr. later. The average weight and standard deviation for steers receiving each treatment is presented in table 1.

Previous analyses of these data indicated a highly significant treatment effect for net ^{40}K count but little or no evidence for treatment carry-over effects from one period to the next. Treatment also significantly influenced steer weight; however, the average weight gained by steers on any one treatment was approximately the same in each period. On the average steers receiving diets A, B and C gained 3.13, 12.06 and 1.93 kg per 2-week period, respectively. Thus, the relationship between ^{40}K count and weight, as affected by potassium in the diet, was studied by regressing ^{40}K count per minute (cpm) loss during shrink on weight loss during shrink for each treatment and by regressing ^{40}K cpm on weight separately for each treatment and for unshrunk and shrunk measurements.

Results and Discussion

Table 2 presents the relationship between ^{40}K cpm loss and weight loss during shrink. The weight loss means and respective standard deviations were quite similar for all treatments. The mean weight loss was somewhat lower for treatment D, but this may be a reflection of the lighter weight of all steers during period 1.

The mean ^{40}K cpm loss during shrink was not as uniform among treatments. As would be expected, when the steers received the two highest potassium diets (A and B) they lost considerably more count than when measured after receiving diet C, however, when the steers received the mixed diet (diet C), they lost the least count during shrink.

The variation that exists in the relationship between weight loss and count loss is evident from observation of the regression coefficients (table 2) and their respective standard errors. Three of these coefficients are significantly greater than zero, diets A and D ($P<.05$) and diet C ($P<.01$). Although the coefficient for diet B was lower than all others and nonsignificant, the large standard error associated

TABLE 2. MEAN WEIGHT LOSS AND ^{40}K COUNT LOSS DURING SHRINK AND REGRESSION COEFFICIENTS, REGRESSING ^{40}K COUNT LOSS ON WEIGHT LOSS, FOR EACH DIET

Diet	No.	Mean weight loss, kg	SD	Mean ^{40}K loss, cpm	SD	Ratio[a]	b	S_b
A	36	23.8	5.3	845.3	434.7	35.5	27.4*	13.2
B	36	23.6	5.9	850.2	474.9	36.0	9.9	13.7
C	36	23.3	7.9	598.4	347.0	25.7	21.7**	6.5
D	35	20.3	6.9	534.3	455.0	22.4	25.3*	10.5
Avg	143	22.8	6.7	708.3	449.2	31.1	22.5**	5.4

[a] Ratio of mean count loss to mean weight loss.
* $P<.05$.
** $P<.01$.

with this coefficient does not suggest it is estimating a value different than the other coefficients. Since there was little evidence that the relationship between ^{40}K cpm loss and weight loss during shrink was different for the various diets, all coefficients were pooled. The pooled regression coefficient of ^{40}K cpm loss on weight loss during shrink was 22.5± 5.4 cpm per kilogram. The standard error of estimate of a prediction equation to predict count loss from weight loss was 424.9 cpm compared to the overall standard deviation of ^{40}K cpm loss during shrink of 449.2 counts per minute.

With the exception of diet B, the regression coefficients are not greately different than the ratio of ^{40}K cpm loss per kilogram weight loss. Repeat observations at 38 data points provided a nonsignificant ($P>.25$) lack of fit test, as calculated by methods described by Draper and Smith (1966). This indicates that there appears to be no reason to doubt that a linear relationship exists between ^{40}K count loss and weight loss measured after a 24-hr. shrink.

The regression coefficients of ^{40}K cpm on weight in kilogram, measured from shrunk and unshrunk observations, and the respective standard errors are shown for each diet in table 3.

All regression coefficients are significantly greater than zero ($P<.01$). There is a tendency for coefficients to be higher for high potassium diets and on unshrunk measurements, although the largest coefficients, both shrunk and unshrunk, were obtained during period 1 when steers received diet D. This again may reflect the influence of lighter weight cattle since a higher percentage of each kilogram gained by lighter weight steers should consist of muscle tissue than a kilogram gained by heavier steers and should therefore result in a greater increase in net ^{40}K count.

TABLE 3. REGRESSION COEFFICIENTS, REGRESSING ^{40}K CPM PER STEER ON WEIGHT IN KG, FOR EACH DIET MEASURED FROM UNSHRUNK AND SHRUNK DATA

Item	Diet	No.	b[a]	S_b
Unshrunk	A	36	18.76	3.77
	B	36	16.32	3.40
	C	36	12.41	4.21
	D	36	18.99	4.04
	pooled	144	14.75	1.92
Shrunk	A	36	15.61	3.44
	B	36	13.56	3.35
	C	36	13.08	3.13
	D	35	16.07	4.26
	pooled	143	12.41	1.76

[a] All regression coefficients are significantly greater than zero ($P<.01$).

The regression coefficients for the various diets were not significantly different from each other, thus all coefficients were pooled to obtain estimates of the increase in ^{40}K cpm for each increase of 1 kg in weight. Pooled unshrunk and shrunk coefficients were 14.74± 1.92 and 12.41±1.76 cpm per kilogram, respectively.

There were 22 data points at which repeat measurements were available from unshrunk data and 26 from shrunk data. In each case a lack of fit test was nonsignificant ($P>.25$) providing evidence that non-linear relationships between ^{40}K count and weight, if they exist, are relatively unimportant.

The ranking of regression coefficients among diets was not consistent with the rank of potassium concentration of diets and there were no significant differences between regression coefficients of the diets, thus these data provided little evidence that the relationship between weight and ^{40}K count or weight loss and ^{40}K count loss is affected by potassium content of the diet. In these data each additional kilogram of fill contributed more to ^{40}K count than did each additional kilogram of weight, although it is difficult to separate the influence of these two factors since fill influences weight. However, measured from shrunk data, each kilogram of weight increased ^{40}K count by 12.4 cpm while each kilogram loss in weight during shrink reduced ^{40}K count by 22.5 counts per minute.

Lohman *et al* (1966) reported that the combination of weight and ^{40}K data for live steers significantly ($P<.01$) increased the variation accounted for by ^{40}K count alone and reduced the standard error of estimate from 5.3 to 3.8 kg when predicting fat-free lean. Lohman and Norton (1968) also indicated that weight may be an important source of variation to ^{40}K estimates of fat-free lean in live animals. In the six body components studied the mean potassium mass of steers increased as weight increased from 306 kg live weight to 544 kg live weight, however the potassium concentration of these components decreased for all components except carcass bone and gastrointestinal tract as weight increased. However, previous work at this station (McLellan, 1969; Frahm, Walters and McLellan, 1971) has shown little increased

precision in estimates of fat-free lean when weight and ^{40}K count were included in a fat-free lean prediction equation.

These data suggest that there is a linear relationship between ^{40}K cpm loss and weight loss measured after a 24-hr. shrink period. Whether this relationship would remain linear over several shrink periods is not known. McLellan (1969) and Frahm *et al.* (1971) have reported no increase in the correlation between ^{40}K count and fat-free lean following a 48-hr. shrink or a 72-hr. shrink compared to a 24-hr. shrink period.

Indications from these data are that the most precise ^{40}K comparisons of fat-free lean between animals can be made when animals are of similar weight and have been subjected to similar conditions prior to counting.

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