**Table 8. Duo-Trio Comparison for the BF, LD and SM Muscles at the 7 Versus 48 Hour Treatments.**

| Duo-Trio Comparison | BF | LD | SM |
|---|---|---|---|
| Total number of comparisons | 48 | 48 | 48 |
| Total number of correct responses | 28 | 29 | 24 |

**Table 9. Preference Rank Analysis for the BF, LD and SM Muscles at the 7 Versus 48 Hour Treatments.**

| Process Treatment | n | BF | LD | SM |
|---|---|---|---|---|
| Chill (48 Hr)[1] | 48 | 1.58 | 1.38 | 1.56 |
| Delay Chill (7 Hr)[1] | 48 | 1.42 | 1.62 | 1.44 |

[1] Larger value denotes increased preference.

panelist evaluating the BF, LD, or SM muscles (Table 9). Only a slight trend for the 48 hour boned steak was shown for the BF and SM muscles. The reverse trend was indicated by the panelsits for the LD muscles as a slight preference for the 7 hour boning treatment was noted.

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# The Use of Phantoms to Determine the Effects of Weight on $K^{40}$ Whole-Body Counting Efficiency

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## Story in Brief

This research was initiated to determine the influence of weight or size on $K^{40}$ counting efficiency. Four phantoms, weighing 500, 700, 900 and 1100 pounds were constructed using square one-gallon plastic containers filled with a saturated sodium salt solution and a known quantity of potassium chloride. The potassium chloride served as the source of gamma-radiation ($K^{40}$). Twenty-four mean net counts were obtained at

each phantom weight. Two counter configurations were used (a small and large counter) in an effort to minimize changes in sample to counter geometry. The 500 and 700 pound phantoms were counted in the small configuration and the 900 and 1100 pound phantoms were counted in the larger configuration. The counts obtained were expressed as a percent of the total possible counts (% counting efficiency) as determined from the known concentration of the radiation source ($K^{40}$).

The data indicated that as phantom weight increased percent counting efficiency decreased on a within configuration basis. As weight increased from 500 to 700 pounds a 13.41% change in counting efficiency was noted. A change in counting efficiency of 8.51% was noted when phantom weight increased from 900 to 1100 pounds. There was a slight increase in counting efficiency as phantom weight increased from 700 to 900 pounds. However, this increase is probably the result of re-establishing a more effective sample to counter geometry as a result of changing from the small to the larger configuration.

In general, the data suggests a tendency to under estimate heavier animals as compared to lighter animals when using whole-body counters, unless adjustments for weight changes are made or unless an effective animal to counter geometry can be maintained. The appropriate adjustments seem dependent on differences in the weight.

## Introduction

Previous reports from Oklahoma State University (1969 and 1970) have discussed the principles on which $K^{40}$ whole-body counters function and the relationship of counting data to measurements of leanness. The percentage of gamma radiation that is counted can differ from animal to animal (sample to sample). Many factors are responsible for this difference, of which changes in sample to counter geometry (space-distance relationship between the animal and the counter detector logs) and the self-absorption of gamma-radiation are the most important.

The potential usefulness of whole-body counting is dependent upon the accuracy with which sources causing variation in the counting data can be identified and corrected. One source of variation is the day to day variation in counting efficiency caused by changes in instrument instability and routine balancing of the electronics. This variation can be corrected for by adjusting the counting data to a common efficiency, equalizing the day to day variation. Counting efficiency is also influenced by characteristics inherent to the animal (i.e.-body size, conformation and the distribution of the muscle mass), changes in animal to counter geometry, self-absorption and background depression by the animal.

A more thorough understanding of the influence of weight or size on counting efficiency and its relationship to the above sources of variation was the purpose of this study.

## Materials and Methods

One-gallon (square) plastic containers were filled with a sodium and potassium salt solution and used to construct phantoms (form of known density and potassium content used to simulate density of an animal and its content) of 500, 700, 900 and 1100 pounds. The dimensions of each phantom were selected to approximate length, width and height measurements of similar weight beef steers. The sodium salt (supersaturated solution) was used to simulate the density of an animal and the potassium chloride (.033% by weight) provided a quantitated source of $K^{40}$.

Twenty-four counts were obtained for each phantom over a three week interval, each count represents the mean of five one minute counts corrected for background radiation. The counter was forced to function at four different efficiency ranges, by changes in instrumentation, to provide variation that might be encountered over time. Six counts were obtained at each efficiency range.

Two different counter configurations were used in this study. A small configuration was designed to accomodate animals weighing between 700 and 800 pounds and under, and large configuration to handle animals weighing 900 and 1100 pounds. Each configuration contains the same plastic scintillation detector logs placed in the same position and constructed to form a "horse-shoe like" tunnel configuration which envelopes the back and sides of the animal. The only difference between the two configurations was in the spacing of the scintillation detector logs and the size of animal the particular configuration could accomodate.

Counter efficiency was calculated by dividing the mean net count per minute (adjusted for background count) of the phantom by the total counts possible from the known quantity of potassium in the phantom.

## Results and Discussion

The mean percent counting efficiency, by configuration, and for each of the four phantom weights is presented in Table 1. The decrease in counting efficiency as phantom weight increased from 500 to 700 pounds represented a 13.41% change in the mean value. A decrease of 8.51% in the mean value in counting efficiency was observed when phantom weight was increased from 900 to 1100 pounds. The only positive change in counting efficiency (2.12%) occurred when weight was increased from 700 to 900, however this change is confounded with the change in counter configuration. The effects of weight on counting efficiency for the small and large counters are shown graphically in Figures 1 and 2, respectfully. It can be seen that as phantom weight increased, the percentage detectable gamma radiation decreased for both the small and large configuration. From this it would appear that there is a tendency to underestimate the counts of heavier cattle compared to lighter cattle, unless an adjustment for the effects of weight is made.

This loss in counting efficiency can be attributed primarily to changes in animal to counter geometry and to the self-absorption of gamma radiation by the sample or animal itself as weight (body mass) increases.

The decrease in counting efficiency caused by changes in the sample to counter geometry is related to how effectively the counter surrounds the sample or animal. This phenomena may explain, in part, the lack of a proportional drop in counting efficiency when the phantom weight increased from 700 to 900 pounds as compared to drop in counting efficiency from the changes of 500 to 700 and 900 to 1100 pounds. It was at the 900 pound weight that the counter configuration was changed; therefore, possibly restoring the sample to counter geometry to a more effective relationship.

Self-absorption, the other phenomena responsible for a decrease in counting efficiency, refers to the inability of a certain portion of the gamma radiations originating with the animal to be counted due to animal size. As animal size increases, the greater is the liklihood that the radiation will lose part or all of its energy before leaving the sample and interacting with the counter. This data indicates the proportion of total $K^{40}$ detected decreases as weight or size increases.

## Literature Cited

C. R. McLellan, Jr. 1969. Animal Science Research Report, Misc. Pub. N-82, Oklahoma State University.

**Table 1. Mean Percent Counting Efficiency by Configuration and Weight.**

| | Configuration | |
|---|---|---|
| Weight | Small counter Counting Efficiency (%) | Large counter Counting Efficiency (%) |
| 500 | 4.25 | |
| 700 | 3.68 | |
| 900 | | 3.76 |
| 1100 | | 3.44 |

R. R. Frahm, 1970. Animal Science Research Report, Misc. Pub. N-84, Oklahoma State University.

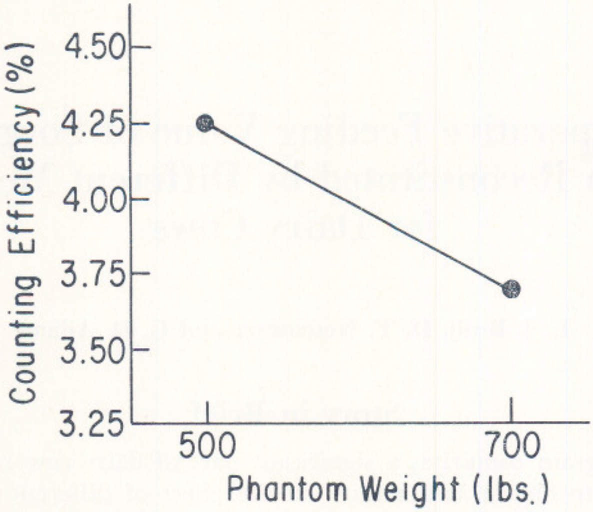


**Figure 1.** **The relationship between % counting efficiency and weight in the small configuration.**

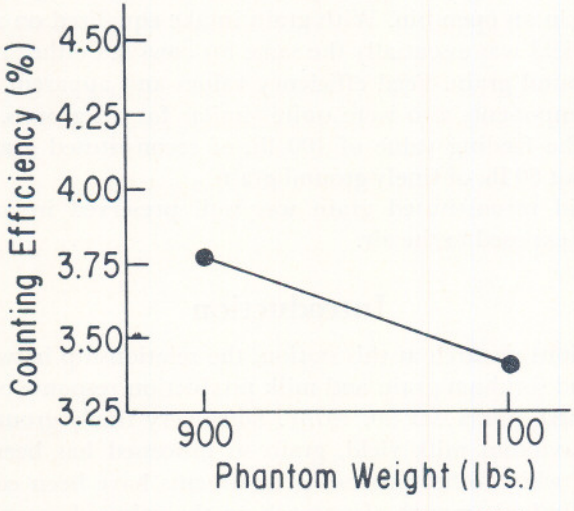


**Figure 2.** **The relationship between % counting efficiency and weight in the large configuration.**