Evaluation of the K^{40} Technique for the Determination of Fat-Free Lean in Ground Meat

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Story in Brief

This research was initiated to investigate the feasibility of using the K^{40} technique as an acceptable method for determining fat-free lean and from this value to estimate ether-extractable materials (mostly fat) in ground meat. The development of whole-body counters such as the O.S.U. whole-body counter, has made it possible to measure gamma radiation arising from the element potassium and thus to predict muscling in meat animals in a non-destructible manner.

There are two properties of potassium that make its quantitative measurement in animals and their tissues useful and practical. First, potassium appears to be relatively independent of body fat and therefore, makes up a relatively constant proportion of the fat-free body when considered within species and age groups. Secondly, the measurement of potassium is possible because a small but constant amount of potassium is radioactive.

A new K^{40} counter configuration (involving eight detectors arranged in a stack) was used in counting ground meat samples. Forty pound lean samples containing five different levels of added fat and lean were prepared and K^{40} counted on two consecutive days in July, 1972. The ratios of lean to fat in the five ground meat samples were representative of the variation found in lean trimmings customarily used in the sausage industry. Net K^{40} count and ether-extract analyses were conducted on the five different samples and fat-free lean values were calculated by difference. The data were analyzed statistically and a prediction equation and correlations were developed.

Introduction

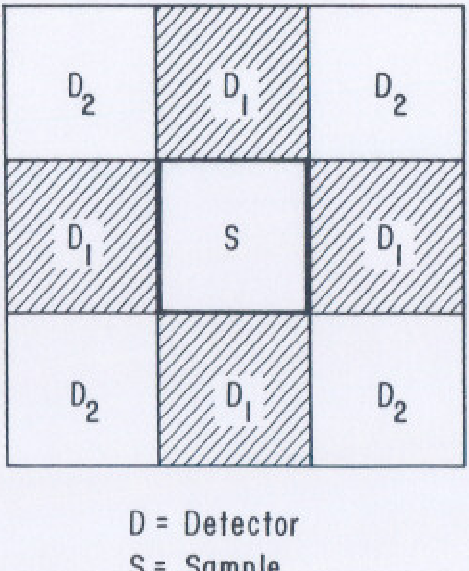
Effective quality control procedures for the meat processing industry require that such methods be rapid and accurate. The sausage industry, in particular, is in need of such methodology for the control of fat concentrations in blended and seasoned products. Currently, laboratory methods in use for the determination of fat (ether-extract) in these products is time consuming and the results of the analyses are often not available until after the product has reached marketing channels. Therefore, in order to produce sausages and other processed meats that have no more fat than is allowed under provisions of a contract or appropri ate label, many processors aim for a fat concentration lower than the permitted level, thus severly reducing profits by manufacturing a leaner product.

The search for a rapid, accurate method for determining fat-free ean (and from this to determine fat concentration by difference) has prompted the investigation into the feasibility of applying the K^{40} tech- ique for this purpose. Such a technique has shown considerable promise n the estimation of fat-free lean in live animals and it would appear hat these principles may well be applicable to animal tissue used in he meat processing industry as well.

Materials and Methods

Eight detectors from the O.S.U. whole-body counter were removed m the cattle counting instrument and positioned in a "star" con- uration in such a manner as to create a tunnel in which ground beef nples were placed for K^{40} counting, Figure 1.

The D_1 detectors were used to monitor gamma radiation arising n muscle potassium in the samples while the D_2 detectors were used ly for support. The ground beef samples (1, 2,3, 4, 5) were prepared adding different levels of fat to different amounts of lean obtained n a common source of very lean beef, Table 1.



. Schematic of tunnel K^{40} counting configuration

Table 1. Composition of Ground Beef Samp...

	Lbs. Lean Ground Beef	Lbs. Added Fat
Sample 1	30.0	10.0
Sample 2	32.5	7.5
Sample 3	35.0	5.0
Sample 4	37.5	2.5
Sample 5	40.0	0.0

The lean was obtained from bull chucks and rounds. It was closel trimmed to remove as much subcutaneous and intermuscular fat as po sible, then ground through a ⅜ inch plate and thoroughly mixed in a mechanical mixer. The source of added fat was beef kidney fat, whic was also ground through a ⅜ inch plate. The components of each sa ple were carefully weighed, thoroughly mixed, re-ground through a inch plate, re-mixed and placed in polyethylene bags for K^{40} counting. the ground meat samples were prepared, 100 gram samples for chemi analysis were taken from each of the five 40 pound samples. Ether-extr analyses using a modified Goldfisch method were conducted in triplic on each of the five 100 gram samples. After the 40 pound samples w prepared, they were transported to the O.S.U. Live Animal Evaluat Center and counted on two consecutive days in July, 1972.

The order for K^{40} counting of the five samples was completely domized. Five two-minute counts were taken on each sample with two-minute background counts taken before and after each sample cc Each of the five two-minute counts per sample was randomized counting order on the first day. The same procedure with a new domization order was repeated on the following day in order th estimate of the day-to-day repeatability of the K^{40} counter could b termined. Samples were stored in refrigeration when not being co After the two days of K^{40} counting, the samples were returned t Meat Laboratory where each sample was thoroughly mixed and sa again for ether-extract analysis. All ether-extract analyses were d triplicate.

Results and Discussion

Five forty pound ground meat samples each containing d amounts of lean were counted in the O.S.U. whole-body K^{40} cou two successive days in July, 1972. Chemical analyses for ether were conducted on the five ground meat samples and fat-free l determined by difference. The K^{40} net count data and the ethe data were analyzed statistically. In the analysis, the logarithm of net K^{40} count data was used to express the magnitude of this variable.

The coefficient of variation,

$$C.V. = \frac{\sqrt{\text{Error Mean Square}}}{\text{Overall Mean}} X\ 100$$

was used as an estimate of the repeatability of K^{40} net count during the experiment. The coefficient of variation for the log net K^{40} count was found to be 2.8 percent.

By comparison, it should be noted that some methods involving analytical apparatus with coefficients of variation up to 6 to 8 percent are considered to be within useful operating limits. The coefficient of variation for the ether-extract procedure was found to be 0.8 percent (this is presented as an estimate of technician error in running the ether-extract analysis).

The plotted data in Figure 2 presents the relationship between log net K^{40} count and fat-free lean in the sample. An approximate 95 percent confidence interval was made on a regression line for predicting log net K^{40} count from fat-free lean. The following equation was developed:

$$\hat{Y} = 3.088 + 0.0150X$$

where $\hat{Y}$ represents the estimate of log net K^{40} count and X represents the average pounds of fat-free lean obtained from twelve ether-extract values from each forty pound ground meat sample. In order to use this equation, one obtains the logarithm net K^{40} count on ten two-minute K^{40} net counts (5 on one day and 5 on the next). The average of these ten logarithms is substituted in the equation for $\hat{Y}$ and the equation is solved for X (which is average pounds of fat-free lean in the forty pound sample):

$$X = \frac{\text{Logarithm Net } K^{40} \text{ Count} - 3.008}{0.0150}$$

The approximate confidence bounds can be found from Figure 2. For example, (see dotted lines in Figure 2), if the average log net K^{40} count for a forty pound sample is 3.62, the estimate for the amount of fat-free lean would be 35.6 pounds with a range from 34.9 to 36.3 pounds. These values were obtained by using the confidence bounds on the regression line. The correlation between log net K^{40} count and pounds of lean in the samples was 0.99 and the correlation between log net K^{40} count and pounds of fat-free lean was 0.96.

It should be emphasized that this prediction equation was developed for forty pound samples of meat which contained between 30 and 39

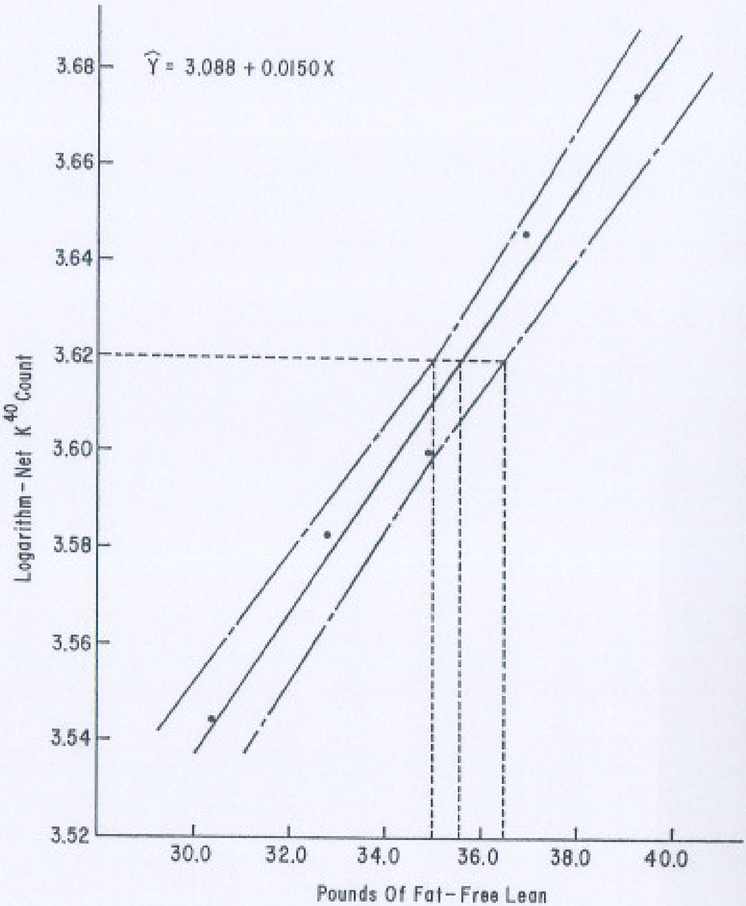


Figure 2. Logarithm-Net K^{40} count as related to pounds of fat-free lean

pounds of fat-free lean. The equation is applicable only to the counting configuration and conditions described above and used in these procedures conducted in the O.S.U. whole-body counter.