A DIFFERENT LOOK AT BEEF CARCASS COMPOSITION

L. E. ORME

UNIVERSITY OF TENNESSEE

Such a topic as this would have been more enlightening to all of us had there been also presented ideas and findings from other stations. Sending questionnaires was considered, but it was felt that this would not be entirely satisfactory since the various workers would most likely be hesitant to give out untested ideas, which is understandable since new ideas are hard to come by. Therefore, this paper presents some of the recent findings of the Tennessee Experiment Station on somewhat new approaches to evaluate the beef carcasses. For simplicity, this paper has been arranged into two parts,namely live animal evaluation and carcass evaluation.

LIVE ANIMAL EVALUATION

Review of Literature

In an attempt to predict and evaluate the ultimate carcass, objective and visual measurements of the live beef animal have been quite extensively investigated. Circumference of heart, girth has been found to be highly correlated to the live weight of both beef and dairy cattle (Johnson, 1940; Lush, 1928, Barton 1939; Wanderstock and Salsbury, 1946; and Kidwell, 1955). Severson and Gerlaugh (1917), Lush (1932), Hankins and Beard (1944), and Yao, Dawson and Cook (1953) have all reported width, depth and circumference measurements to be indicative of the amount of finish possessed by a particular steer or sheep. The relationship of various live animal measurements in beef with the subsequent slaughter grade and dressing percentage has been studied by a great number of investigators (Lush, 1932; Hankins and Beard, 1944; Cook, Kohli and Dawson, 1951; Yao, Dawson and Cook, 1953; Green, 1954). In most cases the above workers found a low but positive correlation between the so-called "fleshing" measurements and either dressing percent or carcass grade. Cook, Kohli and Dawson (1951), White and Green (1952), Green et al. (1955),Dawson et al. (1955), Tallis et al. (1957) Orme et al. (1959) have studied the relationship between body measurements of the live beef animal and various carcass traits. Live weight and various width and depth measurements were found to be quite highly associated with the weight of the wholesale cut. Hankins et al. (1954) studied the relationship of various live animal measurements with the muscle-bone ratios of the 9-10-11 rib section in beef cattle, who found that generally these relationships were quite low and of little value for predictive purposes.

Experimental - Results and Discussion

We have been interested in the past year to establish criteria by which it would be possible to evaluate the beef carcass as to the degree of muscling. Body circumference measurements which included fore flank, middle

(belly), and rear flank were taken on two groups of slaughter steers, in order to further evaluate their association with loin eye area and total separable carcass lean. The above measurements were taken on the first group of 64 steers, first, on foot just at the end of the feeding trial and, second, as they hung on the rail after sticking and before siding. Loin eye tracings and various carcass measurements were also taken.

Repeatability estimates of .82, .63, and .56 were obtained between the two methods (live and rail) for obtaining the above measurements, taken of the same animal. When the position of the animal was changed (Horizontal to the vertical) the circumference of fore flank was affected least and circumference of hind flank most. This could be attributed to the positional change of the contents of the abdominal cavity.

Table 1 shows the simple, multiple correlation and standard partial regression coefficients of the various body circumference measurements with loin eye area and live weight. The three circumference measurements of the live animal, and circumference of fore flank, taken as the animal hung on the rail, were found to be associated with 25-34 percent of the variation in the area of the loin eye. Live animal weight was more highly associated with area of the loin eye (r=.66) than were any of the circumference measurements. The simple correlation coefficients of the various measurements with live weight were higher than were those between a particular measurement and area of loin eye. This would substantiate the findings of earlier workers that circumference taken of the barrel is highly associated with weight.

With the effects of live weight removed statistically, (table 1) the relationships between the various circumference measurements and loin eye area approached zero. This would indicate that the relationship existing between the loin eye area and a particular measurement is due largely to the influence of live weight. Multilinear correlation coefficients of loin eye area with live weight and the various circumference measurements were about equal in magnitude to that of the simple correlation coeffient between area of loin eye and live weight.

Circumference measurements were taken on another group of 46 steers from a types and breed study upon which complete physical separation of the entire carcass was available. In this instance, all measurements were taken as the animal hung on the hoist or rail and included in addition to the three previously mentioned measurements, circumference of the foreshank and round. Simple correlation coefficients were obtained for the various measurements with the weight of separable carcass lean (table 2). The circumference of foreshank was found to be associated with 16 percent of the variation existing in carcass separable lean, which would be in agreement to McMeekan's (1941) results with hogs. Circumference of middle was found to be significantly and negatively related to separable carcass lean. Weight of the live animal showed the strongest association to total carcass lean of all measurements taken, accounting for 33 percent of the variation of total separable lean. With the effects of live weight constant, all relationships between the various measurements and total separable lean were increased with the exception of circumference of foreshank. Circumference of middle in this instance was associated with 42 percent of the

variation in total separable carcass lean. A multiple correlation coefficient of .84 was obtained for circumference of middle and live weight with separable carcass lean.

From the results of this study concerning the relationship of various circumference measurements and live weight with either loin eye area or weight of separable lean it appears that these last two items are more of a function of weight than of a particular measurement, since, 1) with the effects of weight standardized, most of the relationships were lowered, and 2) the simple correlation coefficients were in most cases, higher between live weight and a particular measurement than between the same measurement and either loin eye area or separable carcass lean.

BEEF CARCASS EVALUATION

Review of Literature

Palsson (1939) and Branaman (1940) working with lamb carcasses reported the area of loin eye to be a fairly good index of the total muscling of a particular carcass. Hirzel (1939), Palsson (1939) and McMeekan (1941) have used the depth, length, and "shape index" (length/depth X 100) of the loin eye in evaluating the amount of muscling in pigs and sheep. A better estimate of total carcass lean was obtained when carcass length was combined with the depth and length of the loin eye, since the amount of muscle will be related to the linear as well as the cross-sectioned area. Kline and Hazel (1955) and Price *et al.* (1957) suggested that loin eye area may not be highly related to total muscling in pork carcasses. Cole, Orme, Kincaid (1959) on data including 99 cattle, reported that only about 18 percent of the variation in weight of carcass lean was attributed to the area of loin eye.

The lean of a particular cut has been reported to be a reliable index to total carcass muscling in lambs and beef. (Palsson, 1939; McMeekan, 1941; and Cole, Orme and Kincaid, 1959). The weight of the *Psoas Major* muscle has been investigated by Woodman *et al.* (1936) and McMeekan (1941), in pigs and Orme (1958) in cattle, as a possible index to the degree of muscle development.

Specific gravity has been extensively used by various workers (Brown *et al.*, 1951; Whiteman *et al.*, 1953; Breidenstein *et al.*, 1955; Pearson *et al.*, 1956; Price *et al.*, 1957; Orme *et al.*, 1958; Backus, 1959, and Cole, Backus and Orme 1959) as an objective measure of fat in pork cuts and carcasses and beef cuts.

Experimental - Results and Discussion

Inasmuch as the amount of muscle in a particular carcass will be related to the linear as well as the cross-sectioned area, the area of the *Longissimus dorsi* muscle was taken at three locations, namely, at the fifth and twelfth ribs and at the last lumbar, in an attempt to derive a better estimate of total carcass lean using the area of loin eye. These surfaces would normally be exposed when the carcass is cut into wholesale cuts.

length of carcass and physical separation of fat, lean and bone were obtained for the same ten carcasses. A colored picture of the entire excised Longissimus dorsi is shown in Slide 1. This muscle originates at about the second and third ribs and carries posterially to the crest and sacral angle of the ilium and the first and second sacral spines, where it is attached. As most of you know the Longissimus muscle is quite cylindrical through the rib region, while it tends to flatten out in the loin region. It became quite apparent to us that the area of this muscle fluctuates quite widely. A correlation coefficient of .35 was obtained between the area taken at the 12th rib and total separable lean of the carcass. When an average of the three areas of the loin eye were correlated with separable carcass lean a correlation of .52 was obtained and when the product of this average and carcass length was correlated, a correlation coefficient of .61 was obtained with separable carcass lean. Therefore, an average of the loin eye taken at the three locations or by combining an average of the areas of loin eye with carcass length gave a better indication of the actual muscling for a particular carcass than did loin eye area at the twelfth rib. However if a better estimate of the weight of lean in the carcass is desired, the separable lean of the round, chuck, or foreshank was found to have correlation coefficients of .95, .93 and .81 respectively with total separable carcass lean (Cole, Orme, Kincaid 1959).

Specific gravity of the pork carcass and wholesale cuts of pork have been used as an index to the fat content in pork carcasses and more recently in beef carcase evaluation. Specific gravity of the round (rump removed) and the excised and cleaned Longissimus dorsi muscle from the 9-10-11 rib section was determined for 19 steers to investigate the validity of using these two items as objective measures of the lean, fat, and bone content in the entire carcass and/or round. Physical separation data for the entire side of beef was available for these 19 steers.

Table 3 lists the simple correlation coefficients of specific gravity of the round and the Longissimus dorsi muscle taken from the 9-10-11 rib section with the lean, fat, and bone content of the carcass or of the round. Correlations of -.96 and -.87 were found between specific gravity of the round and separable carcass and round fat respectively. Any one of these relationships were sufficiently high so as to be used to predict carcass or round separable fat, from specific gravity determinations of the round. Specific gravity of the round was also found to be associated with 73 and 69 percent of the variation existing in the weight of bone in the carcass or round. Although highly significant, the relationships found between specific gravity of the round and total carcass or round lean were lower than the relationships previously mentioned between specific gravity of the round and the fat or bone content in either the carcass or round.

Specific gravity of the Longissimus dorsi muscle taken from the 9-10-11 rib section was associated with 72 percent of the variation existing in total separable carcass fat and 44 percent of the variation in separable fat of the round, (table 3). Correlation coefficients .81 and .82 were obtained between specific gravity of the loin eye from the 9-10-11 rib section and the weight of bone in the carcass or round. Specific gravity of the loin eye gave a slightly better estimate of separable carcass lean ($r=.67$) or round lean ($r=.76$) than did specific gravity of the round. Specific gravity of the round was highly related ($r=.88$) with the specific gravity of the Longissimus dorsi muscle from the 9-10-11 rib section.

Future investigations of the beef carcass will be much enhanced through cooperative effort with the specialists in related fields. For instance, the animal genetist should be consulted since various carcass and meat traits such as degree of muscling, tenderness, and the degree of marbling appear to be heritable. Heritability estimates for these and other traits could be used to select animals which possess these desired traits. Working with beef animals differing extremely in breed, conformation and genetic background, it may be possible to develop criteria for measuring the desired characteristics. The animal nutritionist working with the meats specialist could investigate the effects of various feeds and feeding practices on the ultimate physical and chemical carcass composition, grade, organoleptic, etc., properties. Radioisotopies such as carbon^{14}, heavy hydrogen (H^3), and Phosphorous^{32} have great potential in order to study the disposition and metabolism of fat and protein; the activity and isolation of autolytic enzymes; for the assay of tranquilizers, steriod hormones, and other feed additives, etc. In connection with this, the Oak Ridge Institute of Nuclear Studies is giving a course involving the preparation of biochemical radioactive labelled compounds, from September 21 to October 2 at Oak Ridge, Tennessee. Anyone who may be interested in such a course should write to Dr. Overman, Institute of Nuclear Studies, Oak Ridge, Tennessee. If it is your desire to come to Knoxville in 1961, we can arrange for a short course in the use of radioisotopes.

TABLE 1. SIMPLE, MULTIPLE CORRELATION, AND STANDARD PARTIAL REGRESSION COEFFICIENTS OF VARIOUS BODY CIRCUMFERENCE MEASUREMENTS WITH LOIN EYE AREA AND LIVE WEIGHT.

rcumference Measurements Y	Loin-Eye Area X_1	Live Weight X_2	$b^1 x_1 y_i . x_2$ a/	R Loin Eye Area With Live Weight and
ve Animal				
Fore Flank	.58**	.85**	.07	.66**
Middle	.50**	.80**	-.08	.66**
Hind Flank	.53**	.76**	.07	.66**
l				
Fore Flank	.54**	.87**	-.14	.66**
Middle	.26*	.56**	-.16	.67**
Hind Flank	.42**	.57**	.07	.66**
Foreshank	.42**	.63**	.01	.66**
ve Weight	.66**			

a/ Standard partial regression coefficient of area of Loin eye on Y_i, with carcass weight held constan

* Denotes significance at P .05. ** Denotes significance at P. 01.

TABLE 2. SIMPLE, MULTIPLE CORRELATION, AND STANDARD PARTIAL REGRESSION COEFFICIENTS OF VARIOUS BODY CIRCUMFERENCE MEASUREMENTS WITH SEPARABLE CARCASS LEAN AND LIVE WEIGHT.

Circumference Measurements - Rail Y	Separable Carcass Lean X_1	Live Weight X_2	$b^1 x_1 y_i . x_2$ a/	R Separable Carcass Lean with Live weight and
Fore Flank	.23	.71**	-.35	.62**
Middle	-.43**	.29*	-.65	.84**
Hind Flank	-.15	.22	-.29	.63**
Foreshank - Above Elbow	.40**	.55**	.12	.58**
Round	-.02	.21	-.15	.59**
Live weight	.57**			

a/ Standard Partial regression coefficient of separable carcass lean on y_i with carcass weight held constant.

* Denotes significance at P .05. ** Denotes significance at P .01.

TABLE 3. SIMPLE CORRELATION COEFFICIENTS OF SPECIFIC GRAVITY OF THE ROUND OR THE LONGISSIMUS DORSI MUSCLE FROM THE 9-10-11 RIB SECTION WITH SEPARABLE LEAN, FAT, AND BONE OF THE CARCASS AND ROUND, AND CARCASS WEIGHT.

X	"r" Specific Gravity of the Round	"r" Specific Gravity of Longissimus Dorsi
Separable Carcass Fat	-.96	-.85
Total Carcass Bone	.85	.81
Separable Carcass Lean	.57	.67
Separable Round Fat	-.87	-.66
Total Round Bone	.83	.82
Separable Round Lean	.68	.76
Carcass Weight	-.42	-.15
Specific Gravity 9-10-11 Rib Section	.88	1.00

.433 Required for significance at P .05.

.549 Required for significance at P .01.

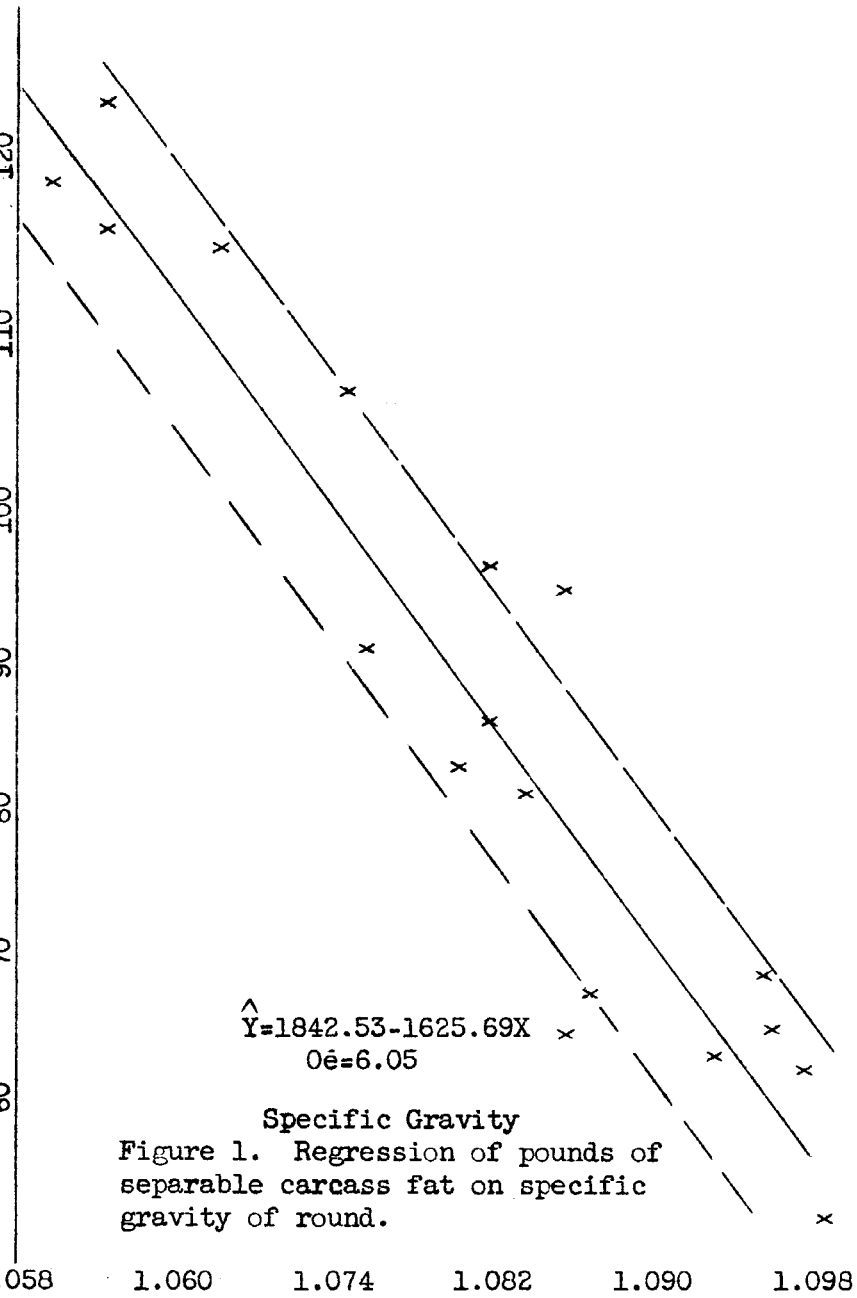

Figure 1. Regression of pounds of separable carcass fat on specific gravity of round.

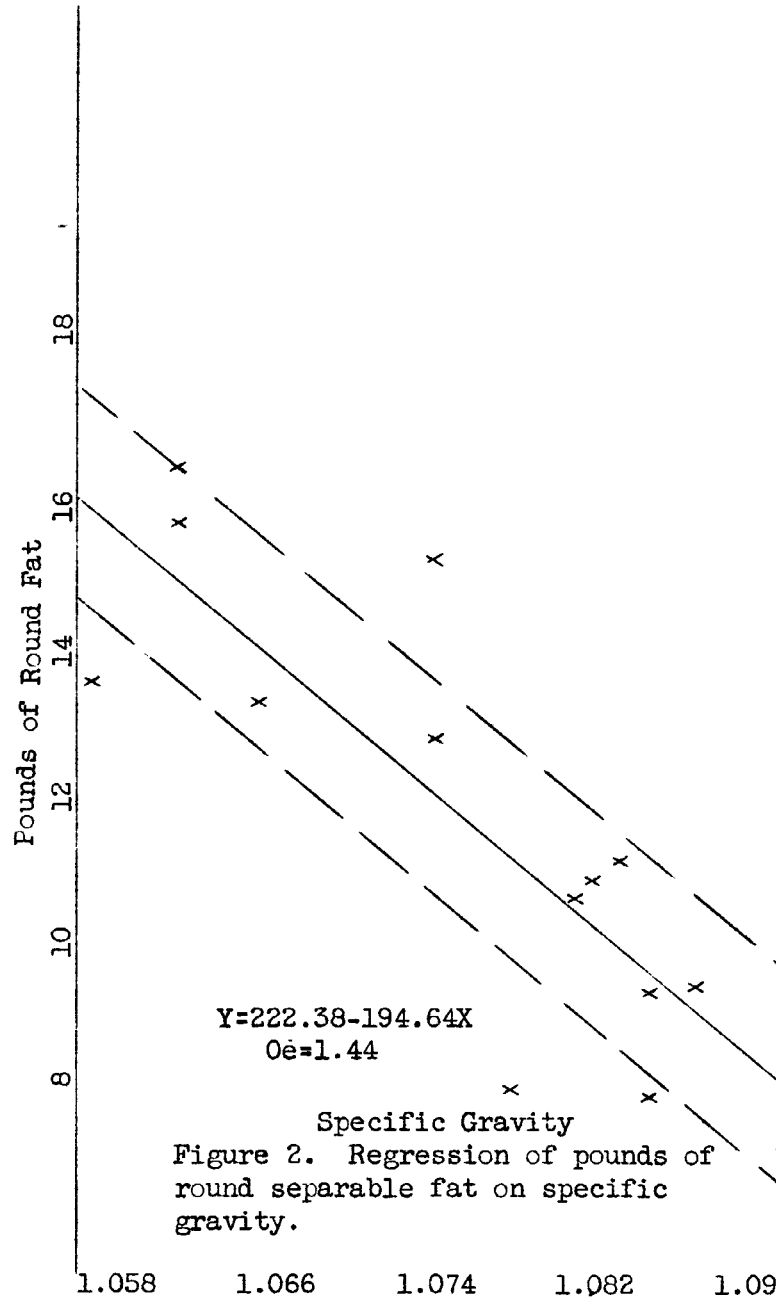

Figure 2. Regression of pounds of round separable fat on specific gravity.

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MR. COLE: Mr. Hedrick, University of Missouri, will lead the discussion. We think this should be rather short, do you agree, Charlie?

MR. ADAMS: Yes, I do.

MR. HEDRICK: I think each of the participants are to be complimented on their fine presentations. Each of the participants have either directly, or indirectly pointed out at least two major problems that confront industry and research worker of the meat technology, these two problems are, one, how to accurately evaluate meatiness of the meat panel and carcass, and second, how to evaluate quality in the meat panel and carcass. These reports I am sure have stimulated thinking on your part on carcass evaluation methods and problems associated with carcass study. If you have questions regarding a formal presentation, problems that confront you in your work, or ideas which you would like to share with the conference, I think we will take a few minutes to give you an opportunity to ask those questions, or share your ideas. Who will be the first with a question or idea?

MR. ROUSEK: (Arizona) Mr. Pierce, are these data of yours going to be published in some form where we can get some idea of measuring variances, and these things?

MR. PIERCE: Yes. I think they will. Some have been published. Some may be. Some of the basic relationships I spoke of were published in the proceedings of the Society of Animal Production, I believe, and we have reprints.