ALTERNATIVE POSITIONS FOR MEASURING FAT THICKNESS ON BEEF CARCASES

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SUMMARY

The relationship between a subcutaneous fat thickness measurement and the weight or percentage of fat and muscle in the carcase has received considerable research attention and fat thickness measurements are commonly used in carcase specification and grading schemes. The objective of the work reported here was to compare fat thickness measurement at 10 sites for the prediction of carcase fat and muscle content.

Seventy-eight grass-fed steers representing three breed types with carcase weights ranging from 97 to 402 kg were slaughtered and fat thickness measurements were taken at 10 anatomically defined sites on the carcase. One side of each carcase was dissected into bone, muscle, fat and connective tissue. Correlation and regression analyses were carried out on the relationships between each fat thickness measurement and the weight and percentage of fat and the weight and percentage of muscle of the carcase.

Seven of the sites produced correlation coefficients of 0.80 or more between the fat thickness measurement and carcase fat weight, while 6 sites produced correlation coefficients of 0.80 or more between the measurement and carcase fat percentage. Two of the sites produced correlation coefficients of 0.80 or more between the fat thickness measurement and carcase muscle weight, while none produced high correlation coefficients with carcase muscle percentage. When used in prediction equations to predict carcase fat weight or percentage, or carcase muscle weight or percentage the RSD's were similar for eight of the ten measurement sites.
It is concluded that there are many sites where fat thickness measurements can be taken to give a reliable prediction of carcase fat or muscle content.

INTRODUCTION

A single subcutaneous fat thickness measurement on beef carcases has been used for the prediction of carcase composition (e.g. Butterfield, 1965; Powell and Huffman, 1968; Charles, 1974; Johnson and Vidyadaran, 1981) and saleable beef yield (e.g. Murphey et al. 1960; Charles et al. 1965; Crouse et al. 1975). The subcutaneous fat thickness measurement has been so widely accepted that it is now included in the carcase classification, grading and price determining schemes in many countries.

The site for the fat thickness measurement has traditionally been over m. longissimus at the 10th or 12th rib positions. An alternative site over the rump region, originally termed the sacral crest site, later changed to P8 site, was proposed by Johnson and Vidyadaran (1981) as it was shown to suffer considerably less damage during carcase skinning and dressing than the 10th or 12th rib sites. A report by Meehan and Taylor (1988) demonstrated that nine out of 15 fat thickness measurement sites on the carcase gave significant correlation co-efficients between fat thickness and side fat percentage. They concluded that there were a number of sites for fat thickness measurement which were more useful for predicting carcase fat content than the traditional 12th rib site.

The current study was conducted to investigate the relationship between fat thickness at 10 anatomically defined sites and the weight or percentage of fat and muscle in the carcase.

MATERIALS AND METHODS

The carcases of 78 grass-fed steers of three breed types were used in this study. Fat thickness measurements were taken by the cut and measure technique at the following anatomically defined sites -

FT10 Three-quarters of the distance from the medial to the lateral edge of m. longissimus at the 10th/11th ribs.

FT12 Same site as FT10 but at the 12th/13th ribs.

SC7 Seven cm lateral to the prominence of the sacral crest, which is the dorsal spine of the 2nd or 3rd sacral vertebra.

P3 A point one-half of the distance from the saggital division (chine) of the thoraco-lumbar articulation to the ventral longitudinal incision separating the sides, measuring at right angles to the vertebral axis.

P5 A point one-third of the distance from the saggital division (chine) of the 3rd/4th lumbar articulation to the ventral longitudinal incision separating the sides, measuring at right angles to the vertebral axis.

P7 A point one-sixth of the distance from the saggital division (chine) of the lumbo-sacral articulation to the ventral longitudenal incision separating the sides, measuring at right angles to the vertebral axis.

P8 The intersection of two lines, one from the dorsal tuberosity of the tripartite tuber ischii passing parallel to the spinal axis, the other from the crest of the spinous process of the 3rd sacral vertebra, meeting the first at right angles.

RS Half-way from the medial to the lateral edge of m. longissimus at the 10th/11th ribs.

BF A point 3 cm cranial to the caudo-dorsal angle of the rhomboid-shaped m. biceps femoris.

FL The thickest part of the layer of intermuscular fat visible between the abdominal muscles at the cranial extremity of the thin flank (10th/11th ribs).

Eye muscle area was measured at the 10th rib cut surface of m. longissimus.

One side of each carcase was dissected into bone, muscle, fat and connective tissue and the weights of these tissues were recorded.

Correlation and regression analyses were carried out on the relationships between each of the fat thickness measurements and the weight and percentage of carcase fat and the weight and percentage of carcase muscle.

RESULTS

The means and ranges of some specific carcase characteristics and of the measurements at the 10 fat thickness sites are shown in Table 1.

Table 1. Means and ranges of carcase characteristics

Trait	Mean	Range
Hot Side Weight (kg)	123.63	48.50 - 201.00
Fat (kg)	23.44	6.39 - 57.30
Fat (%)	19.15	10.63 - 32.83
Muscle (kg)	70.89	27.77 - 108.84
Muscle (%)	63.20	53.72 - 70.01
Fat Thickness Measurements (mm)		
FT10	9.85	0 - 34
FT12	6.01	0 - 31
SC7	8.42	0 - 23
P3	5.59	0 - 23
P5	11.13	1 - 32
P7	4.12	0 - 21
P8	8.41	0 - 27
RS	3.13	0 - 14
BF	5.69	0 - 29
FL	7.23	0 - 25

The large range in carcase weights and fat thickness measurements for the cattle population used in this study is evident from this table.

The correlation co-efficients between carcase measurements and fat weight and percentage and muscle weight and percentage are shown in Table 2. It should be noted that two of the fat thickness measurement sites, P3 and BF, produced considerably lower correlation co-efficients than the other eight sites and that these other eight sites recorded very similar correlation co-efficients with both fat and muscle weight and percentage.

Table 2. Correlation co-efficients between fat thickness measurements at 10 sites and the weight and percentage of fat and muscle.

	Fat (kg)	Muscle (kg)	Fat (%)	Muscle (%)
FT10	0.84	0.68	0.84	-0.76
FT12	0.86	0.73	0.82	-0.70
SC7	0.90	0.82	0.86	-0.75
P3	0.53	0.44	0.51	-0.50
P5	0.85	0.74	0.81	-0.68
P7	0.84	0.73	0.78	-0.70
P8	0.88	0.80	0.85	-0.73
RS	0.81	0.69	0.80	-0.71
BF	0.54	0.50	0.51	-0.41
FL	0.86	0.78	0.78	-0.67
Hot Side Weight	0.95	0.99	0.81	-0.67

All co-efficients are highly significant ($P < 0.01$)

When used alone in regression equations to predict fat weight or percentage and muscle weight or percentage, eight of the fat thickness measurement sites provided similar results (Table 3). The two measurement sites identified above, namely P3 and BF, proved to be less useful predictors. The addition of hot side weight (HSW) and eye muscle area (EMA) to each of the fat thickness measurements produced some improvement in the prediction of fat weight and percentage and muscle weight and percentage. The improvement in this prediction was most noticeable with the P3 and BF sites and the addition of HSW and EMA brought the R.S.D.'s for these sites to the same range of values as those for the other eight sites.

TABLE 3. The RSD and R^2 for simple and multiple regression equations for the prediction of carcase components based on fat thickness measurements made at different sites.

Site	Predition of -							
	Side fat wt. (kg)		Side fat %		Side muscle wt. (kg)		Side muscle %	
	R.S.D.	R^2	R.S.D.	R^2	R.S.D.	R^2	R.S.D.	R^2
FT10	7.33	0.70	2.82	0.74	15.76	0.51	2.26	0.57
FT10 + HSW + EMA	3.35	0.94	2.46	0.81	2.85	0.98	2.02	0.67
FT12	6.09	0.80	2.73	0.76	13.48	0.64	2.37	0.54
FT12 + HSW + EMA	3.31	0.94	2.58	0.79	2.96	0.98	2.11	0.64
SC7	5.65	0.83	2.70	0.76	11.83	0.73	2.29	0.56
SC7 + HSW + EMA	3.48	0.93	2.53	0.80	2.93	0.98	2.04	0.66
P3	11.36	0.28	4.74	0.26	20.18	0.19	3.00	0.25
P3 + HSW + EMA	3.77	0.92	2.83	0.74	3.03	0.98	2.13	0.64
P5	6.51	0.77	2.91	0.72	12.44	0.70	2.45	0.50
P5 + HSW + EMA	3.32	0.94	2.43	0.81	2.87	0.98	2.01	0.67
P7	6.57	0.76	3.13	0.68	13.44	0.65	2.40	0.52
P7 + HSW + EMA	3.38	0.94	2.67	0.77	2.85	0.98	2.06	0.65
P8	5.99	0.80	2.70	0.76	12.27	0.71	3.29	0.57
P8 + HSW + EMA	3.53	0.93	2.53	0.79	2.97	0.98	2.06	0.65
RS	7.69	0.68	3.15	0.68	15.75	0.51	2.39	0.53
RS + HSW + EMA	3.52	0.93	2.63	0.78	3.03	0.98	2.10	0.64
BF	10.38	0.41	4.41	0.37	17.61	0.39	3.03	0.24
BF + HSW + EMA	3.86	0.92	2.88	0.73	3.16	0.98	2.21	0.60
FL	6.25	0.79	3.20	0.67	11.78	0.73	2.51	0.45
FL + HSW + EMA	3.56	0.93	2.76	0.75	3.03	0.98	2.15	0.62

HSW = hot side weight EMA = eye muscle area at 10th rib

DISCUSSION

The 78 cattle utilized in this work were slaughtered in a research abattoir with careful carcase skinning and dressing procedures. Thus, damage to individual fat thickness measurement sites was negligible and the concern with damage to sites under commercial conditions, as discussed by Johnson and Vidyadaran (1981), was not a consideration in the present work.

The high correlation co-efficients between the fat thickness measurements at 8 of the sites and fat weight and percentage and muscle weight and percentage, is evident in Table 2. This is in agreement with the report of Meehan and Taylor (1988) who utilized a more limited cattle population than that involved in the present study. Meehan and Taylor (1988) recorded highly significant correlation co-efficients ($P < 0.01$) between fat thickness measurements at 9 sites on beef carcases and side fat percentage, with correlation co-efficients ranging from 0.67 to 0.90.

The prediction of side fat weight and percentage and side muscle weight and percentage using the fat thickness measurements alone was relatively accurate for eight of the 10 sites studied. This is consistent with the report of Johnson and Vidyadaran (1981) who found that four sites were of approximately equal accuracy in predicting side fat percentage (R.S.D.'s of 2.82% - 3.12%) and side fat weight (R.S.D.'s of 4.50kg to 5.42kg). Likewise, Johnson and Priyanto (1991) reported close similarity in prediction of side fat percentage and side muscle percentage when either fat thickness at the 12th rib or at the rump P8 site was used. Kempster (1983) using data from 600 carcases reported very similar R.S.D.'s for the prediction of carcase lean percentage using fat thickness measurements at 6 sites on the back of the carcase from the 6th rib to the 3rd lumbar vertebra.

The inclusion of hot side weight and eye muscle area in prediction equations for fat weight and percentage and muscle weight and percentage produced a small improvement in prediction accuracy for those sites where the R.S.D. for the prediction using fat thickness alone was relatively low. However, these two added variables produced a larger improvement at those sites (P3 and BF) which had higher R.S.D.'s and brought these R.S.D.'s to approximately the same level as those of the other eight sites. Thus, it appears that inadequacies associated with the relationship between fat thickness at some sites and fat and muscle weight and percentage can be largely overcome by the inclusion of HSW and EMA in prediction equations.

The results reported here support the conclusions of previous workers that there is more than one site on a beef carcase where fat thickness can be measured to predict carcase composition (Johnson and Vidyaran 1981, Kempster 1983, Meehan and Taylor 1988). The decision on the site to be used in a carcase evaluation program may be made on other factors such as susceptibility to dressing damage, accuracy of locating and convenience of use in commercial conditions.

REFERENCES

Butterfield, R.M., (1965). The relationship of carcase measurements and dissection data to beef carcase composition. Res.Vet.Sci. 6: 24-32.

Charles, D.D. (1974). A method of estimating carcase components in cattle. Res.Vet.Sci. 16: 89-94.

Charles, D.D., Butterfield, R.M. and Francis, J. (1965). Marketing beef by specifications. Agriculture (London) 1965, p. 190.

Crouse, J.D., Dikeman, M.E., Koch, R.M. and Murphey, C.E. (1975). Evaluation of traits in the U.S.D.A. yield grade equation for predicting beef carcass cutability in breed groups differing in growth and fattening characteristics. J.Anim.Sci. 41: 548-553.

Johnson, E.R. and Priyanto, R. (1991). Mechanisms for improving the prediction of carcase composition using subcutaneous fat thickness. Proc. 37th International Congress of Meat Science and Technology, Kulmbach, Germany. pp. 123-126.

Johnson, E.R. and Vidyadaran, M.K. (1981). An evaluation of different sites for measuring fat thickness in the beef carcase to determine carcase fatness. Aust.J.Agric.Res. 32: 999-1007.

Kempster, A.J. (1983). Recent developments in beef carcass evaluation. Outlook on Agriculture. 12: 147-152.

Meehan, D.P. and Taylor, D.G. (1988). A comparison of positions for fat thickness on beef carcasses. Proc.Aust.Soc.An.Prod. 17: 440.

Murphey, C.E., Hallett, D.K., Tyler, W.E. and Pierce, J.C.Jr. (1960). Estimating yields of retail cuts from beef carcasses. J.Anim.Sci. 19: 124 (abstr.).

Powell, W.E. and Huffman, D.L. (1968). An evaluation of quantitative estimates of beef composition. J.Anim.Sci. 27: 1554-1558.