

THE RELATIONSHIP BETWEEN BONE FLATNESS AND BEEF YIELD

E.R. JOHNSON*, D.P. MEEHAN** and D.G. TAYLOR***

SUMMARY

Subjective and measured indices of bone 'flatness' (ratio of width to thickness) were determined in 14 Brahman and Brahman x Hereford steers which were subsequently slaughtered and dissected to evaluate their percentages of saleable beef yield, carcass muscle and carcass fat. Both subjective and measured indices were poor predictors of carcass yield, muscle and fat and could not be recommended as selection factors to improve beef yield. Other simple measurements, P8 fat thickness and anal fold fat thickness, with or without the addition of carcass weight or empty live weight respectively, were poor predictors of percentage saleable beef yield but highly significant predictors of percentage carcass muscle and percentage carcass fat.

INTRODUCTION

For over half a century the size and shape of bone in cattle have been described by breeders, growers and scientists as commercially important (McMeekan 1956; Wythe et al. 1961; Freer 1984). Few bone shape associations have, however, been scientifically substantiated. In Australia, a private Company exists, which offers graziers a professional evaluation of their cattle as a tool for improving herd productivity. The evaluation includes a subjective identification of bone 'flatness', based mainly on the metacarpus (shin), the metatarsus (shank) and ribs. In this evaluation a metacarpus or metatarsus with a larger value for the radio cranio-caudal length over transverse width is 'flatter' than a similar bone with a lower value; similarly ribs with a larger value for the ratio width over thickness are 'flatter'. The Company recommends selection for 'flat' bone characteristics because, it maintains, the greater the degree of 'flatness', the higher the yield of saleable beef. A Company member subjectively evaluated the 'flatness' of bone in 14 steers in the present study. The steers were subsequently slaughtered and dissected to determine saleable beef yield and total anatomical composition.

This paper reports findings on the relationships between bone flatness and percentages of saleable beef yield, carcass muscle and carcass fat.

MATERIALS AND METHODS

Seven Brahman steers (7-30 months) and seven Brahman x Hereford steers (7-32 months) weighing 293 to 588 kg were subjectively scored for 'flat' or 'round' bone. The assessor used principally the shin in evaluating bone flatness (Subjective Shin Flatness) but he evaluated also, 'ribs', 'body image' (the total skeleton) and 'rear leg' (principally tibia, patella and metatarsus) in a more generalised estimation (Subjective Total Flatness). In each of the two evaluations he scored within the range 0 to 50. The Company assessor stated that bone flatness evaluations made in cattle, other than the very young calf, apply for the life of the animals. The steers were slaughtered from 3 days to 23 weeks after evaluation, dressed and their carcasses were chilled at 2°C. The dentition of each animal (the number of erupted permanent incisor teeth)

* University of Queensland, Vet. School Farm, Pinjarra Hills, Qld. -4069.

** Livestock and Meat Authority of Queensland, MLC Centre, 239 George Street, Brisbane, Qld. 4000.

*** University of Queensland, Gatton College, Lawes, Qld. 4343.

was recorded at slaughter. Each right side was dissected to determine its saleable beef yield (SBY) and anatomical composition using a technique described by Johnson and Ball (1989). After dissection, two samples of bone were taken from each side, a one-centimetre length from mid-shin (metacarpus) and a one-centimetre length of the sixth rib at a point where brisket is separated from crop (a straight line from the reflection of the diaphragm at the 11th rib to the articulation of the 1st rib with the sternum). The width and thickness of each bone sample were measured with a vernier caliper, and width was divided by thickness to derive a Shin Flatness Index or a Rib Flatness Index.

Simple and multiple regression analyses were used to estimate carcass percentages of saleable beef yield, muscle and fat from various live animal or carcass measurements. Coefficients of determination (r^2) were calculated.

RESULTS AND DISCUSSION

Table 1 shows the coefficients of determination and the significance of regression when subjective and measured bone indices were used to estimate the percentages of saleable beef yield, muscle and fat in the carcass.

Table 1 Coefficients of determination (r^2) and regression coefficients (b) for relationships between predictors (bone measurements and indices) and saleable beef yield (SBY%), carcass muscle (M%) and carcass fat (F%)

Predictor	Prediction					
	SBY%		M%		F%	
	(Mean = 70.63)		(Mean = 63.93)		(Mean = 16.80)	
	r^2	b	r^2	b	r^2	b
Subjective Total Flatness	0.19	0.04 ^{n.s.}	0.01	0.03 ^{n.s.}	0.09	0.02 ^{n.s.}
Subjective Shin Flatness	0.39	0.12*	0.24	0.24 ^{n.s.}	0.13	-0.28 ^{n.s.}
Shin Flatness Index ^A	0.20	-7.14 ^{n.s.}	0.41	-26.36*	0.41	42.35*
Rib Flatness Index ^A	0.02	0.27 ^{n.s.}	0.03	0.88 ^{n.s.}	0.03	-1.30 ^{n.s.}

* $P < 0.05$; n.s., not significant

^A Flatness Index determined by dividing width by thickness

Subjective Total Flatness was of no use in estimating percentages of carcass yield, muscle or fat. The regression coefficient for the relationship between Subjective Shin Flatness and SBY (%) was statistically significant ($P < 0.05$) but only 39% of the variation in SBY was explained by the relationship. This method of evaluation is unlikely to be of any real value in the selection of live cattle for beef yield. From the measured indices of bone flatness, Shin Flatness Index significantly estimated percentages of muscle and fat ($P < 0.05$) but since this index explained only 41% of variance in each, it is unlikely to be of value in the selection of superior-yielding cattle. It should be noted that for percentage muscle, the regression was negative whereas it was positive for the estimation of percentage fat. This means that as the shin became flatter, carcass muscle decreased and carcass fat increased. Further statistical analysis showed that Shin Flatness Index was positively correlated with dentition ($r^2 = 0.40$). Therefore, if yield increases with increasing shin flatness (and age), as stated by the practising Company, it is not due to a higher proportion of muscle in the carcass.

Relationships between objective and subjective measurements of bone flatness were not significant except for that between Shin Flatness Index (x) and Rib Flatness Index (y) for which $r^2 = 0.41$ and $b = -0.56$ ($P < 0.05$). This negative relationship indicates that, as the shin becomes flatter, the rib becomes

rounder. This is incompatible with the advice of the professional valuator who uses increasing flatness of either the shin or the ribs as an indicator of increasing carcass yield.

Table 2 The estimation of saleable beef yield (SBY%), carcass muscle (M%) and carcass fat (F%) from live animal and carcass measurements

Predictor		Prediction								
Fat thickness	Weight	SBY%			M%			F%		
		(Mean = 70.63)			(Mean = 63.93)			(Mean = 16.80)		
		r ²	r.s.d.	Sig.#	r ²	r.s.d.	Sig.#	r ²	r.s.d.	Sig.#
P8 (chilled) ^A		0.12	1.31	n.s.	0.70	1.97	***	0.81	2.52	***
P8 (chilled)	+ CCW	0.27	1.41	n.s.	0.77	1.85	***	0.85	2.29	***
P8 (estimated)		0.25	1.40	n.s.	0.57	2.26	**	0.59	3.35	**
P8 (estimated)	+ ELW	0.28	1.40	n.s.	0.73	2.01	***	0.78	2.74	***
Anal fold ^B		0.32	1.34	*	0.74	1.75	***	0.76	2.58	***
Anal fold	+ ELW	0.34	1.38	n.s.	0.75	1.79	***	0.80	2.46	***

CCW Chilled carcass weight

ELW Empty live weight

A P8 fat thickness (Moon 1980)

B Anal fold fat thickness (Charles 1974)

Significance of regression : *, P<0.05; **, P<0.01; ***, P<0.001;

n.s. not significant

Some other, currently used measurements and one subjective estimate of fatness were made on the cattle and the carcasses used in this investigation. The results are shown in Table 2. None of these independent variables, either alone or in multiple regressions, provided a satisfactory prediction of saleable beef yield although they were useful in predicting carcass composition. This finding is particularly important but not unexpected, in view of the accumulating evidence that percentage saleable beef yield is an unsatisfactory scientific parameter. For example, in attempts to predict percentage SBY using fat thickness measurements and carcass weight, Johnson (1987) and Johnson and Ball (1988 a,b) were unable to explain any more than 39% of the variance in regression. The finding of particular significance in the present study is that while currently-accepted carcass composition predictors (fat thickness and carcass weight were highly correlated with percentage muscle and percentage fat ($r^2 = 0.57$ to 0.77 and 0.59 to 0.85 respectively) measurements and estimates of flat bone were not ($r^2 = 0.01$ to 0.41 and 0.003 to 0.41 respectively).

In a large anatomically-based investigation of saleable beef yield involving 78 carcasses, the authors of the present study showed that the large range of fatness in SBY% (commercial beef yield) seriously questioned its validity as a scientific parameter (Johnson et al. 1990).

CONCLUSION

Both subjective estimates and measurements of bone 'flatness' were poor predictors of percentage saleable beef yield, carcass muscle percentage and carcass fat percentage, P8 fat thickness (measured or estimated), with or without chilled carcass weight, and anal fold fat thickness, with or without empty live weight were poor predictors of percentage saleable beef yield but highly significant predictors of carcass muscle percentage and carcass fat percentage,

Because of their poor relationships with beef yield, carcass muscle and carcass fat, assessments of bone flatness are unlikely to be useful in the selection of cattle or carcasses for meat yield characteristics.

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