AN EVALUATION OF THE USDA AND MURPHEY CUTABILITY PREDICTION EQUATIONS AMONG SEVERAL CATTLE BREED TYPES

D.S. Hale[3], D.S. Buchanan[2], L.E. Walters[1],
J.W. Oljen[2] and R.R. Frahm[1]

Story in Brief

The accuracy of the USDA and Murphey carcass cutability prediction equations, among different breed types, were tested using carcass information from 173 steers. There were four breed groups studied that differed in percent Exotic, British, Brown Swiss, and Jersey breeding.

When breed types were pooled these equations accounted for only 42-44% of the total variation in carcass cutability. The USDA and Murphey equations accounted for different amounts of variation within each breed type, ranging from 21-26% in the 1/2 Exotic X 1/4 British X 1/4 Jersey cross steers to 65-67% in the 3/4 Exotic X 1/4 British cross steers. Separate equations were developed for each breed type. The constants in those equations were different for each breed type, indicating that there are different breed type relationships between carcass cutability and fat thickness, hot carcass weight, rib eye area, and kidney, heart, and pelvic fat. Therefore, there appears to be some limitations to using the USDA and Murphey equations over all breed types of cattle.

Introduction

Accurate, reliable predictors of carcass cutability are needed in beef marketing programs. These predictors must be rapid, inexpensive, and repeatable. In addition, cutability prediction equations must take into account the sex, breed, and feedlot history variation encountered in today's beef industry. Prediction equations are developed using sub-samples of the total cattle population and these equations will perform best for cattle closely resembling the type of cattle in that sub-sample. Caution should be taken when using equations developed from small groups for dissimilar cattle types.

In 1965 the USDA adopted an equation that predicts the percent of a beef carcass that is in the form of closely trimmed, boneless retail cuts from the round, loin, rib, and chuck (TBRC). Another commonly used prediction equation for TBRC is the Murphey equation. Both cutability equations were derived from work done prior to 1965 on carcasses of unknown history. Although breed type was

[1] Professor, [2] Assistant Professor, [3] Graduate Assistant

unknown, one can speculate that the carcasses were from small framed cattle, primarily of British type breeding. Obviously, there have been changes in beef cattle type and an influx of new breeds since the development of these equations. Several investigators have tested the validity of the USDA and Murphey equations, but few have studied their predictive ability for different crossbreds. The objective of this study was to examine the accuracy of the USDA and Murphey cutability equations across several breeds types.

Experimental Procedure

Animal History

Data were obtained from 173 steers born during the 1976-1979 calf crops at the Lake Carl Blackwell Research Range (Stillwater). Calves were weaned at an average age of 205 days and trucked to the Southwest Livestock and Forage Research Range (El Reno). These steers were self-fed a corn based finishing ration and slaughtered, in small groups, when they had reached an anticipated carcass quality grade of low choice. These cattle were from an extensive crossbreeding study designed to evaluate productivity of various two-breed cross cows. Steers were produced from mating Charolais and Limousin bulls to Hereford X Angus, Hereford X Simmental, Angus X Simmental, Hereford X Brown Swiss, Angus X Brown Swiss, Hereford X Jersey, and Angus X Jersey cross cows. These steers were placed into four groups according to their proportion of Exotic, British, Brown Swiss, and Jersey breeding. Table 1 presents the procedure for grouping breed types.

TABLE 1. Breed type grouping procedure.

Breed Type[a]	Sire	Dam
1/2E X 1/2B	Charolais	Angus X Hereford
	Limousin	"
3/4E X 1/4B	Charolais	A or H[b] X Simmental
	Limousin	"
1/2E X 1/4B X 1/4BS	Charolais	A or H X Brown Swiss
	Limousin	"
1/2E X 1/4B X 1/4J	Charolais	A or H X Jersey
	Limousin	"

a - E=Exotic, B=British, BS=Brown Swiss, J=Jersey
b - A=Angus, H=Hereford

Carcass Measurements

Forty-eight hours postmortem, carcasses were ribbed at the 12th rib and routine quality and yield grade factors taken. Actual carcass cutability was determined using the left side of each carcass. Sides were first divided into the standard wholesale cuts. The wholesale cuts were then trimmed to within .3 inch of external fat cover and all seam fat greater than .25 inch was removed. Finally, wholesale cuts were boned, leaving only the vertebral processes in the shortloin. Actual cutability was calculated by weight of closely trimmed, boneless wholesale cuts from the round, loin, rib, and chuck, multiplied by 2, and divided by hot carcass weight. This cutting procedure is not identical to the cutting procedure used to obtain the original USDA and Murphey equations. Those researchers trimmed external fat to .5 inch and seam fat was not removed from all cuts.

Correlation coefficients were calculated in order to examine relationships between carcass cutability and other carcass measurements. Additionally, regession analysis was used to evaluate the predictive ability of existing equations in determining carcass cutability.

Results and Discussion

Cattle Characterization

Means and standard deviations of carcass traits are presented by breed type in table 2. The hot carcass weight, 12th rib fat thickness, rib eye area, and kidney, heart, and pelvic fat ranges in these data were like those commonly encountered in the packing industry, with the exception that very few cattle in this study had fat thickness greater than 1.0 inch. Therefore, the majority of these cattle had yield grades of either 2 or 3, with only a few carcasses having yield grades of 4. Yield grade is determined using a prediction equation and it is a number commonly used in the packing industry to estimate carcass cutability. Yield grades range between 1.0 and 5.9, with 1.0 carcasses having the highest and 5.9 carcasses the lowest estimated carcass cutability.

Correlation Coefficients

The degree of association or relationship between two traits can be measured by calculating correlation coefficients. The correlations between common carcass measurements and actual carcass cutability are shown in table 3. Aside from yield grade, rib eye area had the highest correlation coefficient with actual cutability ($r=.46, p<.01$). Previous research has shown fat thickness to have the greatest relationship with actual carcass cutability. This decrepency may be due to the greater number of heavier muscled exotic type cattle, in this

TABLE 2. Means and standard deviations of carcass traits by breed type.

Breed Type[a]	N	Hot carcass weight lb	Fat thick- ness in	Rib eye area sq in	Kidney heart pelvic fat %	Yield grade	Actual cutability %
1/2E X 1/2B	44	731	.46	13.55	3.2	2.74	48.5
		(67)	(.16)	(1.65)	(.8)	(.82)	(4.5)
3/4E X 1/4B	31	773	.44	14.02	3.0	2.65	48.1
		(76)	(.16)	(1.52)	(.7)	(.83)	(2.7)
1/2E X 1/4B X 1/4BS	45	774	.46	13.61	3.4	2.80	47.4
		(66)	(.15)	(1.43)	(.6)	(.70)	(2.9)
1/2E X 1/4B X 1/4J	53	688	.42	12.70	3.5	2.80	46.4
		(59)	(.16)	(1.18)	(.7)	(.70)	(2.8)

a - E=Exotic, B=British, BS=Brown Swiss, J=Jersey

Table 3. Simple correlation coefficients between carcass measurements and actual cutability.

Variable	Actual Cutability r
12th rib fat thickness	-.41**
Rib eye area	.46**
Hot carcass weight	-.15
Kidney, heart, and pelvic fat	-.40**
Yield Grade	-.65**
Marbling	-.21**

** P<.01

study, in which there was a relatively small amount of variation in fat thickness. Data indicates that fat thickness has a moderate relationship with actual carcass cutability ($r=-.41, p<.01$). This negative correlation means that as fat thickness increases the actual carcass cutability decreases. The lowest relationship existed between hot carcass weight and actual cutability ($r=-.15, p<.26$). This was expected since the heavier weight 3/4E x 1/4B cattle may have a similar or a higher carcass cutability than the lighter weight 1/2E X 1/4B X 1/4J cattle. Yield grade had only a moderate relationship with actual carcass cutability ($r-.65, p<.01$).

Regression Analysis of Carcass Cutability

The accuracy of the USDA and Murphey equations for esimating carcass cutability was examined within each breed type group and overall breed types. Table 4 presents coefficients of determination (R^2 values) and the

Table 4. R and average difference between cutability predicted by the USDA and Murphey equations and actual cutability, overall and among breed types.

Grouping[a]	USDA R^2	USDA-Act. Diff%[b]	MURPEY R^2	Mur-Act Diff%[b]
Overall	.42	2.83	.44	2.64
1/2E X 1/2B	.44	2.33	.41	2.20
3/4E X 1/4B	.67	2.07	.65	2.04
1/2E X 1/4B X 1/4BS	.48	2.65	.48	2.46
1/2E X 1/4B X 1/4J	.21	3.85	.26	3.50

a - E=Exotic, B=British, BS=Brown Swiss, J=Jersey
b - The difference between cutability estimated using the USDA and Murphey equations and the actual cutability

Table 5. Multiple regression equations and R^2 for predicting cutability overall breeds and within each breed type

EQUATION[a]	R^2	Intercept	Fat thickness	Rib eye area	Kidney heart pelvic fat	Hot carcass weight
USDA		51.34	-5.784	.74	- .462	-.0093
Murphey		52.56	-4.95	.682	-1.06	-.008
OSU Equations						
Overall	.45	49.066	-3.958	1.023	-1.209	-.0131
1/2E X 1/2B	.45	51.34	-5.827	.654	- .288	-.0116
3/4E X 1/4B	.72	51.828	-5.424	1.643	-1.032	-.0270
1/2E X 1/4B X 1/4BS	.54	58.749	-6.011	.775	-1.123	-.0199
1/2E X 1/4B X 1/4J	.27	48.009	-4.137	.580	-1.315	-.0038

a - E=Exotic, B=British, BS=Brown Swiss, J=Jersey difference between the predicted cutability, using these two equations, and the actual carcass cutability determined by the carcass cutting procedure used in the study. R^2 values indicate the amount of variation in cutability that a prediction equation can explain. The closer the R^2 value is to 1.0 the more accurate the equation. The USDA and Murphey prediction equations accounted for similar amounts of variation in carcass cutability. When breed types were pooled, these two equations accounted for less than half (R^2 =.42-.44) of the total variation. These equations identified the most variation within the 3/4E X 1/4B breed type cattle (R^2 =.65-.67) and the least within the 1/2E X 1/4B X 1/4J (R^2 =.21-.26). Previous studies have shown that dairy type cattle tend to deposit a higher proportion of their total carcass fat as kidney fat and seam fat and a lower proportion as external fat cover than beef type cattle. It appears that neither of these prediction equations account for appreciable breed differences in fat deposition.

The USDA and Murphey equations consistently overestimated actual carcass cutability (table 4). This may have been due to differences in cutting procedures. Carcass cutability of the 1/2E X 1/4B X 1/4J breed type was considerably more overestimated than the other breed types, indicating that possibly more seam fat was removed from these carcasses.

Separate equations were developed for each breed type and overall breed types. The constants that correspond to each factor in the equation are presented in table 5. These constants represent the biological relationships between the equation factor (i.e. fat thickness, rib eye area, hot carcass weight, and kidney, heart, and pelvic fat) and carcass cutability. The values within the 1/2E X 1/2B and 3/4E X 1/4B equations were similar to those values in the USDA and Murphey equations, with the exception of the rib eye area constant in the 3/4E X 1/4B equation and the hot carcass weight constant value in the 1/2E X 1/2B equation. The constant values within the equations for the other two breed types were quite different from those of the USDA and Murphey equations, indicating that different breed types may have different relationships between carcass cutability and the equation factors.

The R^2 for each equation represents the amount of variation accounted for, within that breed type grouping. The R^2 of these equations were similar to the USDA and Murphey equations R^2 in table 4.

Conclusion

Relationships between actual carcass cutability and other carcass measurements are not the same for all breeds of cattle. Therefore, there are limitations to using the USDA and Murphey equations on all breeds of cattle. Although it is not feasible to use separate equations for each breed under typical industry procedures, a new carcass cutability prediction equation should be developed using large data sources that vary greatly in breed type, sex, and feedlot history.