BODY CONDITION SCORE, LIVE WEIGHT AND WEIGHT:HEIGHT RATIO AS ESTIMATORS OF CARCASS COMPOSITION IN NONPREGNANT, NONLACTATING, MATURE HEREFORD COWS

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Story in Brief

Body condition score (CS), live weight (LW) and weight:height ratio (WTHT) were evaluated and compared as estimators of carcass composition in beef cows. Seventy-one mature, nonpregnant, nonlactating Hereford cows ranging in LW, CS and WTHT from 606 to 1311 lbs, 2.0 to 8.0 units and 12.82 to 25.86 lb/inch of height, respectively, were slaughtered. Live weight, CS or WTHT predicted total carcass energy (mcal; r^2 = .81, .85 or .83), carcass fat (lb; r^2 = .78, .82 or .80), carcass protein (lb; r^2 = .71, .74 or .70) and carcass water (lb; r^2 = .78, .71 or .77) with similar accuracy, respectively. When composition was expressed on a per unit weight basis, condition score was superior to live weight or weight:height ratio as a predictor of energy/lb of hot carcass weight, energy/lb live weight, and percent fat in the carcass (r^2 = .82 vs .60 and .64, .83 vs .58 and .62, and .82 vs .64 and .68, respectively). Correlation coefficients between predictor variables and percent water or percent protein in the hot carcass were low and regression equations developed to predict percent water or percent protein were of limited value. These data indicate that CS was the more useful predictor of carcass composition in mature cows.

(Key Words: Body Condition, Weight:Height Ratio, Carcass Composition, Beef Cows.)

Introduction

The relationship between weight, body condition and reproduction in beef cows has been well established. For many years animal scientists and producers have been searching for accurate, precise and nondestructive methods to estimate carcass energy stores in beef cows for research and management. Objective techniques range in sophistication from simple measurements of live weight (LW) to complex double isotope dilution procedures. In addition, a number of subjective scoring systems have been developed to describe body condition. Relatively few attempts have been made to quantify these scoring systems.

The objective of this research was to evaluate and compare condition score (CS), LW, and weight:height ratio (WTHT) as estimators of carcass composition in mature, nonpregnant, nonlactating Hereford cows.

Materials and Methods

Seventy-one mature, nonpregnant, nonlactating Hereford cows were

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slaughtered as part of a regression study investigating the effects of carcass composition on energy requirements for maintenance during the winter. Prior to slaughter and after an overnight (16h) withdrawal of feed and water, each cow was weighed and evaluated visually and by palpation and assigned a body condition score (Table 1) by two independent observers. Hip height (HPHT) was determined on all cows prior to the initiation of the trial. WTHT was computed by dividing LW(lb) by HPHT(in).

Cows were slaughtered at a commercial slaughter plant. Hot carcass weight (HCW) was measured. Kidney, heart and pelvic fat were removed, weighed and sampled within 30 min of death. Carcasses were cooled for two days and the right side of each carcass was delivered to the Oklahoma State University meat laboratory where the chemical composition of the edible carcass tissue was determined.

Dry matter was determined by drying duplicate samples for 48 h at 212°F in a vacuum oven. Dry samples were weighed and extracted with ethyl ether (B.P. 95°F) in a Soxhlet apparatus for 48 h (AOAC, 1975). Ash content was estimated by combusting the remaining residue at 1112°F for 8 h. Total nitrogen was determined on duplicate samples by the Kjeldahl procedure (AOAC, 1975). Percent protein was calculated as Kjeldahl nitrogen x 6.25.

Total carcass energy (TMCAL, mcal) was estimated by the equation: TMCAL = carcass fat (FAT, lb)*4.26 mcal/lb + carcass protein (PRO, lb)*2.54 mcal/lb (NRC, 1984). Kidney, heart and pelvic fat was includ-

Table 1. Condition scoring system.

Score	Description
1 --	Severely emaciated. All ribs and bone structure easily visible and physically weak. Animals have difficulty standing or walking. No external fat present by sight or touch.
2 --	Emaciated. Similar to 1, but not weakened.
3 --	Very thin. No palpable or visible fat on ribs or brisket. Individual muscles in the hind quarter are easily visible and spinus processes are very apparent.
4 --	Thin. Ribs and pin bones are easily visible and fat is not apparent by palpation on ribs or pin bones. Individual muscles in the hind quarter are apparent.
5 --	Moderate. Ribs are less apparent than in a 4 and have less than 1/2 cm of fat on them. Last 2-3 ribs can be felt easily. No fat in the brisket. At least 1 cm of fat can be palpated on pinbones. Individual muscles in hind quarter are not apparent.
6 --	Good. Smooth appearance throughout. Some fat deposition in brisket. Individual ribs are not visible. About 1 cm of fat on the pin bones and on the last 2-3 ribs.
7 --	Very good. Brisket is full, tailhead and pin bones have protruding deposits of fat on them. Back appears square due to fat. Indentation over spinal cord due to fat on each side. One to two cm of fat on last 2-3 ribs.
8 --	Obese. Back is very square. Brisket is distended with fat. Large protruding deposits of fat on tailhead and pin bones. Neck is thick. Three to four cm of fat on last 2-3 ribs. Large indentation over spinal cord.
9 --	Very obese. Description of 8 taken to greater extremes.

ed in the calculation of FAT. Carcass energy content per pound HCW (ECCW) and per pound LW (ECLW) was computed by dividing TMCAL by HCW or LW, respectively. Proportion FAT (FATPR), PRO (PROPR) and carcass water (WATPR) were computed by dividing FAT, PRO and carcass water (WAT) respectively, by HCW. Contribution of carcass bone to carcass fat, protein and water was not accounted for.

Results and Discussion

The mean and standard deviation of each of the variables in the data set are summarized in Table 2. Cows varied widely in LW (606 to 1311 lbs) and CS (2.0 to 8.0 units). Hip height and WTHT ranged from 43.75 to 50.75 inches and from 12.82 to 25.86 lb/inch of height, respectively.

Simple correlation coefficients between LW, CS, WTHT, HPHT and estimates of composition are displayed in Table 3. These data were obtained from cows utilized in a study in which large ranges in body condition and LW were created prior to the initiation of the trial. Increasing the range of these data may increase the magnitude of correlation coefficients.

The measurements of LW, CS or WTHT show a similar degree of association with TMCAL (r = .90, .92 and .91), FAT (r = .88, .91 and .90), PRO (r = .84, .86 and .84) and WAT (r = .88, .84 and .88), respectively. When energy and fat are expressed on a percentage basis, however, CS (r = .90, .91 and .91) appeared to be more closely related to ECCW, ECLW and FATPR respectively, than LW (r = .76, .76 and .80) or WTHT (r = .80, .77 and .83).

The correlation between WTHT and LW in this study was greater than .98. Consequently, the degree of relationship between WTHT or LW and the other variables measured is likely to be similar. Correlation coefficients between HPHT and other variables were low (r = .30, .19, .14, .28, .19, .36, -.03, .38 and -.17 for TMCAL, ECCW, ECLW, FAT, FATPR,

Table 2. Summary of slaughter data used to generate correlation coefficients and prediction equations.

Item	Mean	Standard Deviation
Live weight, lb	877.4	146.57
Condition score, units	5.1	1.45
Hip height, in	47.8	8.05
Weight:height, lb/in	18.5	2.86
Carcass fat, lb	59.9	40.18
Carcass protein, lb	67.4	14.08
Carcass water, lb	249.0	45.05
Hot carcass weight, lb	472.5	101.87
Total carcass energy, mcal	426.7	202.15
Carcass energy/lb HCW[a]	.86	.25
Carcass energy/lb LW[b]	.45	.15
Carcass fat, %	11.7	5.83
Carcass protein, %	14.3	1.48
Carcass water, %	53.1	3.63

[a]Hot carcass weight.
[b]Live weight.

Table 3. Correlation coefficients between live weight, condition score, hip height, weight:height ratio and estimates of carcass composition[a].

	TMCAL	ECCW	ECLW	FAT	FATPR	PRO	PROPR	WAT	WATPR
LW	.90	.76	.76	.88	.80	.84	-.08[b]	.88	-.43
CS	.92	.90	.91	.91	.91	.86	.07[b]	.84	-.40
HPHT	.30	.19[b]	.14[b]	.28	.19[b]	.36	-.03[b]	.38	-.17[b]
WTHT	.91	.80	.77	.90	.83	.84	-.08[b]	.88	-.44

[a]LW = live weight; CS = condition score; HPHT = hip height; WTHT = weight:height ratio; TMCAL = total carcass energy; ECCW = TMCAL x lb^{-1} hot carcass weight; ECLW = TMCAL x lb^{-1} LW; FAT = carcass fat; FATPR = percentage carcass fat; PRO = carcass protein; PROPR = percentage carcass protein; WAT = carcass water; WATPR = percentage carcass water.
[b]Probability >.05.

PRO, PROPR, WAT and WATPR, respectively). There appeared to be little relationship between PROPR and LW, CS, HPHT or WTHT (r = nearly zero).

Equations for predicting carcass energy from LW, CS and WTHT are shown in Table 4. When carcass energy was expressed on an absolute basis (TMCAL), CS, LW and WTHT predicted carcass energy with a similar degree of accuracy (r^2 = .85, .81 and .83, respectively). However, when carcass energy was expressed on a per unit weight basis, CS accounted for more of the variations in ECCW and ECLW (r^2 = .82 and .83) than LW (r^2 = .60 and .58) or WTHT (r^2 = .64 and .62).

Equations for estimating carcass fat from LW, CS or WTHS are shown in Table 5. When carcass fat was expressed on a total pounds basis, CS, LW and WTHT predicted FAT with similar accuracy (r^2 = .82, .78 and .80, respectively). When carcass fat is expressed as a percentage of hot carcass weight, CS accounted for more variation in FATPR than LW or WTHT (r^2 = .82 vs. .64 and .68, respectively).

Table 4. Equations for estimating carcass energy from live weight, condition score or weight:height ratio.

Equations		Sy·x[a]	R^2
TMCAL[b]	= -221.5 + 128.19 CS[c]	79.14	.85*
	= -661.5 + 1.24 LW[d]	89.06	.81*
	= -756.7 + 64.49 WTHT[e]	85.16	.83*
ECCW[f]	= .067 + .1572 CS	.242	.82*
	= -.313 + .0013 LW	.355	.60*
	= -.441 + .0710 WTHT	.338	.64*
ECLW[g]	= -.024 + .0971 CS	.143	.83*
	= -.241 + .0008 LW	.223	.58*
	= -.319 + .0428 WTHT	.213	.62*

[a]Standard error of the regression.
[b]Total carcass energy, mcal.
[c]Condition score, units.
[d]Live weight, lb.
[e]Weight:height ratio, lb/in.
[f]Mcal/lb carcass.
[g]Mcal/lb live weight.
*P<.001.

Table 5. Equations for estimating carcass fat from live weight, condition score or weight:height ratio.

Equations		Sy·x[a]	R^2
FAT[b]	= -66.96 + 25.093 CS[c]	7.72	.82*
	= -152.91 + .243 LW[d]	8.56	.78*
	= -172.22 + 12.650 WTHT[e]	8.14	.80*
FATPR[f]	= -6.75 + 3.645 CS	2.46	.82*
	= -16.30 + .032 LW	3.52	.64*
	= -19.34 + 1.690 WTHT	3.32	.68*

[a]Standard error of the regression.
[b]Total carcass fat, lb.
[c]Condition score, units.
[d]Live weight, lb.
[e]Weight:height ratio, lb/in.
[f]Percent fat in hot carcass.
*P<.001.

Discussion

The close relationship between CS and the estimates of carcass energy and composition indicates that CS can be used to estimate carcass composition in cows. When estimates of carcass components are expressed on an absolute basis (lb or mcal), LW and CS predict composition with about equal accuracy. However, when carcass components are expressed on a percentage basis, CS is superior to LW as a predictor of composition. Although subjective in nature, CS offers sufficient accuracy for many research and management situations. Data from this study indicate that 76% of the variation in LW, 85% of the variation in carcass energy and 82% of the variation in carcass fat was explained by condition score.

Literature Cited

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