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TRIMMED BONELESS PRIMAL CUTS AND OTHER CARCASS CHARACTERISTICS OF SERIALLY SLAUGHTERED CATTLE OF TWO MATURE SIZES INDIVIDUALLY-FED CORN OR CORN SILAGE RATIONS IN TWO HOUSING TYPES

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INTRODUCTION

The logical end points at which different breeds of cattle, under a specified set of management and environmental influences, produce desirable carcasses for specific markets may vary. By using regression and covariance analysis, serial slaughter offers an opportunity to choose a logical end point when assessing group or treatment effects on carcass characteristics (Berg *et al.*, 1978). The objectives of this study were to examine effects of the energy density of the diet, breed type and housing regimen on carcass characteristics and yield attributes of cattle serially slaughtered over a range of 182 kilograms.

MATERIALS AND METHODS

Experimental design. Thirty-seven Angus calves from a herd of small mature size cows (approximately 400 kg mature weight) and 35 Holstein calves from many different dairy herds were used in this study to represent extremes in mature size. These cattle had USDA feeder calf grades of small frame, number 1 thickness, and large frame, number 2 thickness for Angus and Holstein, respectively. Average initial weights at the beginning of the experiment were 219.14 $\pm$ 14.48 and 233.94 $\pm$ 26.31 kg for Angus and Holsteins, respectively. Cattle were randomly assigned within breed to inside individual pens or conventional lots with electronic feeding doors. They were *ad libitum* fed either a high corn grain ration or a corn silage ration with appropriate supplements (Thonney *et al.*, 1980). Within each breed and across each ration and type of housing, cattle were slaughtered at five weights. Preassigned slaughter weights and the experimental design are in table 1.

Experimental procedure. When an animal reached its designated slaughter weight, it was held off feed and water for 18 hr prior to transport 15 miles to the abattoir. After slaughter, the hot carcass weight (HCW) was obtained and carcasses were chilled at 1° C. Seven days post slaughter, a randomly selected side (wholesale cut side, WCS) from each carcass was quartered between the 12th and 13th rib, as outlined by Wellington (1953) and Schoonover *et al.* (1967), with the modification that the saw cut was made through the upper 1/3 of the 12th thoracic vertebrae of the hanging carcass side. Carcass sides were scored for maturity and evaluated for marbling (intramuscular fat) on the exposed surface of the *Longissimus m.* by comparison with photographic standards (Wellington and Stouffer, 1959) and consensus of at least four appraisers who also estimated the percentage kidney, pelvic and heart fat (EKPH). Quality and yield grades were calculated according to USDA official standards for beef carcasses (Carpenter *et al.*, 1977).

Longissimus m. areas were traced and an average of three measurements was taken using an electronic graphic calculator - planimeter (Numonic Corp., North West Pennsylvania). A single measurement of external fat thickness over the *Longissimus m.* was made. Wholesale cuts were separated following a procedure adapted from AMSA guides for beef carcass evaluation (Schoonover *et al.*, 1967), and grouped into primal (chuck, rib, loin and round) and non-primal (brisket, shank, flank and plate) categories. Primal cuts were trimmed to 1 cm external fat and weighed (TPC). The other side and the non-primal cuts from the WCS were deboned. Total bone of WCS was calculated using the fractional content of bone in deboned side. Non-primal cuts bone was subtracted from total bone to provide primal cuts bone weight.

TABLE 1. EXPERIMENTAL DESIGN

Breed	Housing	Ration	363	408	454	499	544	590	635
			Slaughter weight, kg						
			--------Number of animals ---------						
Angus	Conventional	Corn grain	1	2	2	2	2		
		Corn silage	1	2	2	2	2		
	Individual pens	Corn grain	2	1	2	2	2		
		Corn silage	2	2	2	2	2		
Holstein	Conventional	Corn grain			1	2	2	1	1
		Corn silage			1	2	2	2	1
	Individual pens	Corn grain			2	2	2	2	2
		Corn silage			2	2	2	2	2

Statistical analysis. Analysis of covariance (Snedecor and Cochran, 1976) was used to partition variance associated with the main effects of ration, breed, location, their interactions and a weight covariate. Deviation from a common regression for each main effect was tested by the extra sum of squares method (Draper and Smith, 1966). Significant main effect deviations from common regression were included in the model.

RESULTS AND DISCUSSION

While dressing percentage is often used as an indicator of weight of carcass for a given live weight, we chose to regress hot carcass weight on live weight. Hot carcass weight increased ($P<.005$) .744 kg for each kg increase in shrunk live weight (table 2) and this relationship was independent of ration, breed and location. Although there was a significant ($P<.05$) ration by breed by location interaction, in any ration-location subclass Angus cattle produced heavier carcasses at the same live weight (table 2, figure 1). Data in table 3 show that, in any breed-location subclass cattle fed grain produced heavier carcasses than cattle fed silage and that, in any breed-ration subclass cattle fed in confinement produced heavier carcasses than cattle fed in conventional lots. The absolute difference between rations, breeds or locations depended, however, on the other subclasses. The difference between Angus and Holsteins is consistent with previous observations (Berg and Butterfield, 1976; Callow, 1961; Cole *et al.*, 1965; Maiga, 1974; and Wellington, 1971) and may be a reflection primarily of differences in fatness intrinsic to differences in mature size between breeds and to differences between rations and locations in energy available above maintenance and muscle deposition. However, variations between Angus and Holstein cattle for gutfill and non-carcass components were observed by Simpfendorfer (1974).

Values for quality grade, fat thickness, ribeye area, EKPH and yield grade all increased ($P<.005$) as carcass side weight increased (table 2). Angus carcasses graded 2/3 unit higher than Holstein carcasses, but only 2 Angus and 5 Holsteins, all at the lightest slaughter weights, had marbling scores below the small degree. The observation that energy density of the diet had no influence on quality grade (marbling) is consistent with reports by Young and Kauffman (1978) and Radloff *et al.* (1972). However, Utley *et al.* (1975) observed more marbling in carcasses from cattle finished on a higher energy diet. *Longissimus m.* area increased (P<.005) .196 cm^2 for each kg increase in cold side weight (table 2). Angus carcasses measured 5 cm^2 greater (P<.005) than Holstein carcasses at the same weight. This is in agreement with Maiga (1974) and Wellington (1971).

TABLE 2. MEAN EFFECTS AND COVARIATE FOR EACH RESPONSE VARIABLE

Effect	Hot carcass weight, kg[a,c]	Quality grade[b]	Fat thickness[b], cm	Ribeye[i] area[b], cm^2	Estimated KPH fat[b], %	Yield grade[b]	Primal cuts weight[b], kg
Ration (Grain-silage)	5.94(2.14)[d,y]	.222(.314)	.080(.095)	-1.204(1.656)	-.019(.099)	.126(.128)	-4.22(4.92)
Breed (Angus-Holstein)	29.64(2.60)[z]	2.180(.332)[z]	-.598(.638)	5.018(1.746)[y]	2.436(.664)[z]	.979(.137)[z]	-8.92(4.96)[v]
Location (Individual-Conventional)	5.78(2.14)[y]	-.044(.314)	1.998(.952)	3.098(1.656)	.030(.099)	.030(.130)	-1.05(5.04)
b(weight)[e]	.744(.017)[z]	.063(.007)[z]	.0124(.002)[z]	.196(.035)[z]	.026(.002)[z]	.025(.003)[z]	.598(.011)[z]
b_{A-H}(weight)[f]	-	-	.012(.002)[z]	-	-.014(.002)[z]	-	-
Mean at mean weight[a,b]	308.8	14.2[g]	1.1	71.1	3.04	3.19	115.3

[a] Covariate is shrunk live weight which averaged 495.2 kilograms.
[b] Covariate is cold carcass side weight which averaged 151.8 kilograms.
[c] Significant (P<.05) ration x breed x location interaction.
[d] Number in parenthesis is standard error of the mean.
[e] Common covariate or change in response variable for each 1 kg heavier weight.
[f] Difference in covariate between Angus and Holstein.
[g] 10 = average good, 13 = average choice, 16 = average prime.
[h] Higher numbers mean lower expected yield of retail meat from primal cuts.

[v] P<.1
[x] P<.05
[y] P<.025
[z] P<.005

[i] Ribeye area = Longissimus muscle area.

Since it has been demonstrated that there is an insignificant breed difference in muscle weight distribution (Berg and Butterfield, 1976), the variations in *Longissimus m.* area between cattle breeds observed in this study could be explained by their differently shaped muscles; Holsteins had longer and thinner muscles than Angus cattle.

At lighter side weights, fat thickness measurements were about the same in Angus and Holstein steers, but with increased carcass side weight, fat thickness increased .012 cm/kg increased side weight more for Angus than Holsteins. Angus steers had more EKPH than Holsteins at lighter weights. However, EKPH increased .014 percentage units less per kg increased side weight for Angus than Holsteins. Thus, in the range of conventional slaughter weights, Angus steers have more subcutaneous fat at any given carcass weight than Holstein steers. Similar conclusions were reported by Adams *et al.* (1973), Dikeman *et al.* (1977) and Wellington (1971). Energy density of the diet had no significant effect on fat thickness (table 2) which agrees with the findings of Theunick *et al.* (1977) and Miller *et al.* (1977). However, other investigators (Kauffman *et al.*, 1968; Utley *et al.*, 1975; and Woody *et al.*, 1978) concluded that percentage of grain in the diet significantly influenced carcass fat thickness. On the other hand, Maiga (1974) suggested that only breed had a significant (P<.01) influence on fat thickness in young growing animals, but breed and level of energy intake had a significant effect during the fattening phase.

TABLE 2. CONTINUED

Effect	Non-primal cuts weight[b], kg	Trimmed primal cuts weight[b], kg	Trimmed boneless primal cuts weight[b], kg	Trimmed boneless primal cuts weight[a,c] kg
Ration	.318(.482)	-.694(.544)	-.496(.790)	.636(1.020)
Breed	-6.26(3.66)[v]	5.480(3.720)	10.370(6.000)	6.680(1.204)[z]
Location	-.040(.466)	-.488(.556)	.686(.762)	2.034(.998)[w]
b(weight)	.308(.011)[z]	.558(.012)[z]	.516(.019)[z]	.196(.009)[z]
b_{A-H}(weight)	.072(.011)[z]	-.082(.012)	-.080(.019)[z]	-
Mean	35.2	104.8	90.5	90.1

Yield grade increased 0.025 unit/kg increase in side weight. There was no ration or location effect. However, Angus carcasses yield graded .979 units higher (P<.005) than Holsteins at any given cold side weight. Thus, Holsteins had higher expected yield of retail meat from high priced cuts, which supports the conclusions of Cole *et al.* (1965), Sim (1975) and Wellington (1971).

Figure 2 illustrates the relationship of primal cuts weight (PC) to cold side weight. PC increased (P<.005) .598 kg for each kg increase in cold side weight (table 2). Holsteins had 8.92 kg more (P<.1) PC than Angus steers (table 2). This is in agreement with the findings of Dikeman *et al.* (1977) for Holsteins *vs* heavy British beef breeds.

Luitingh (1962) observed lower proportions for most of what was considered in this study as primal cuts (shoulder, chuck, bottom, and rump) in the carcasses of the fattened steers than unfattened steers in beef cattle. From Luitingh's (1962) observations and the findings of this study, it is suggested that Angus produced more hot carcass weight and had greater fat content (Nour *et al.*, 1980) than Holstein steers. This was expected to increase the proportion of PC, but on the contrary, it was reflected in lower weights of PC probably because the extra fat was deposited in other parts of the carcass as observed by Luitingh (1962).

Non-primal cuts (NPC) increased (P<.005) .308 kg for each kilogram increase in cold side weight (table 2). Although at lighter weights the yield of NPC was similar in the two breeds; in Angus it increased with increasing side weight at a significantly (P<.005) faster rate than in Holstein steers. The faster rate of increase for Angus could be due to the deposition of fat primarily in the brisket, flank and plate. These findings are in agreement with Luitingh (1962) who compared the yield of the ventral parts of the carcass (comparable parts to the NPC) in fattened and unfattened beef steers. He concluded that these parts, where fat was deposited, formed a significantly (P<.01) larger portion of the carcass in fattened than unfattened steers.

Nour *et al.* (1980) showed that the increase in rib weight in these Angus steers was mainly due to deposition of

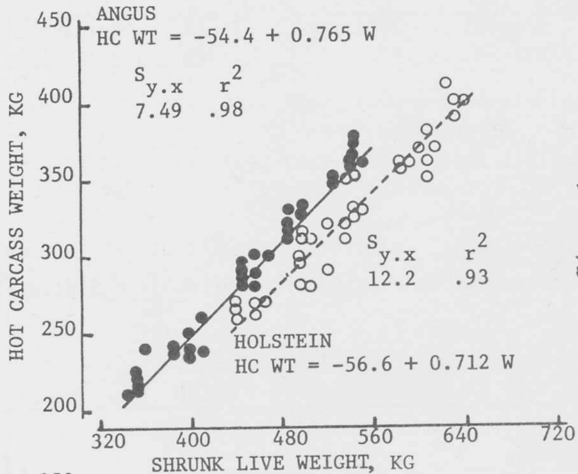

Figure 1.

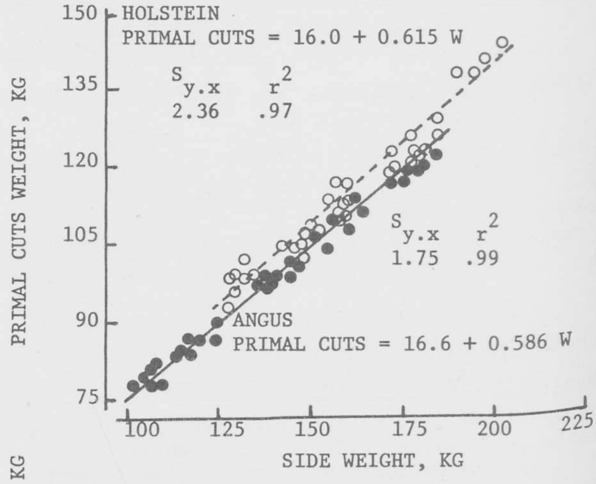

Figure 2.

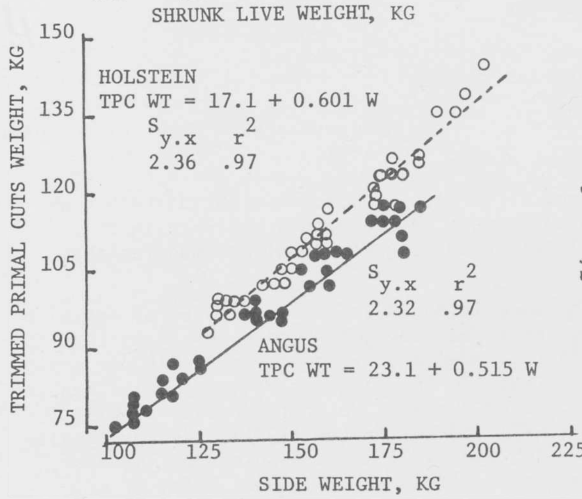

Figure 3.

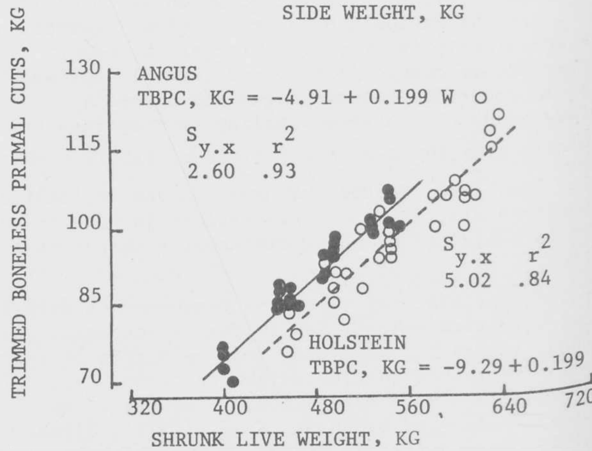

Figure 4.

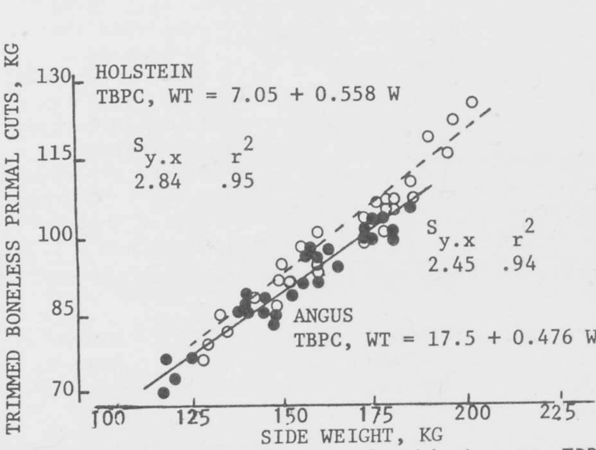

Figure 5.

fat, which even surpassed muscle growth at heavier weights. From these observations and the above mentioned discussion of rate of increase of NPC, it could be concluded that the additional increment in carcass weight in Angus steers was deposited mainly as fat in the ventral parts of the body. Similar observations were reported by Luitingh (1962) who concluded that fattening beef steers resulted in a faster growth rate and greater increase in weight for those parts of the carcass that command the lowest price and the least demand.

Figure 3 illustrates the relationship between trimmed primal cuts (TPC) and cold side weight in Angus and Holstein steers. TPC increased (P<.05) .558 kg for each kg increase in cold side weight (table 2). Moreover, neither breed, ration or location influenced the yield of TPC. When SLW was the covariate, TPC differences favored Holsteins (+1.17 kg) in individual housing and Angus (+5.29 kg) in conventional housing.

Figure 4 illustrates the relationship between TBPC and shrunk live weight (SLW). TBPC increased (P<.005) .196 kg for each kg increase in SLW (table 2). A three way ration-breed-location interaction significantly (P<.005) influenced the yield of TBPC. However, at any given SLW, Angus produced more (table 3, P<.005) TBP cuts in all locations than Holstein steers. The difference varied (table 3) in the conventionally housed cattle from 12.00 kg for the grain-fed, to 5.96 kg for the silage-fed steers. For individually housed cattle, breed differences were 1.36 and 6.21 kg for grain and silage rations, respectively. Lower yield of TBPC from live weight of Holstein steers was due mainly to greater gut fill and heavier non-carcass components than in the Angus. Similar observations were reported by Simpfendorfer (1974).

Figure 5 illustrates the relationship between trimmed boneless primal cuts (TBPC) and cold side weight. At lighter weights, Angus and Holstein carcasses yielded similar amounts of TBPC, but with increasing weight, the rate of growth of TBPC was .080 kg/kg cold side weight (P<.05) greater for Holstein than for Angus carcasses. Holsteins increased .556 kg and Angus .476 kg for each kg increase in 7 day postslaughter side weight (table 2).

Since no attempt was made in this study to trim the intermuscular fat from the TBPC, it could be argued that the picture for actual yield of TBPC would be different. Truscott *et al.* (1976) suggested that the weight of intermuscular fat was similar at the same total fat weight for Friesian and Angus steers. This is consistent with observations of Dikeman *et al.* (1977). Therefore, with trimming of intermuscular fat, Holstein carcasses would maintain their superior yield of TBPC.

These results suggest that packers should pay more for live Angus than live Holstein steers unless the non-carcass components fetch a good market price to compensate for lower yields. On the other hand, to a packer who is only interested in the yield of trimmed primal cuts, this study suggests that carcasses from both breeds would result in similar yields of TPC. The retailer, however, is interested in carcasses that will yield more PC, TPC and TBPC. Holstein carcasses would be a better choice for retailers than Angus carcasses.

TABLE 3. SUBCLASS DEVIATIONS FROM MEAN WITH SHRUNK LIVE WEIGHT AS COVARIATE

	Angus				Holstein			
	Grain		Silage		Grain		Silage	
Response variable	Individual	Conventional	Individual	Conventional	Individual	Conventional	Individual	Conventional
Hot carcass weight, kg	18.11	16.95	14.51	9.71	-3.73	-16.79	-17.33	-18.77
Trimmed boneless primal cut weight, kg	2.60	5.30	3.22	2.23	1.24	-6.70	-2.99	-3.74

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