THE EFFECTS OF BREED AND WINTER SUPPLEMENT LEVEL OF COWS ON FEEDLOT PERFORMANCE AND CARCASS CHARACTERISTICS OF THEIR PROGENY

By

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF TABLES (Continued)

CHAPTER I

INTRODUCTION

The performance of straightbred Holstein steers has been evaluated by many researchers. These workers have found Holstein steers to gain faster, reach heavier slaughter weights and have a less desirable carcass than straight Hereford or Angus steers. The ability of calves with 25 or 50% Holstein breeding to compete with straight British bred calves has not been determined. As more cow-calf operators infuse Holstein breeding into their cow herd to increase milk production, more calves with percentage Holstein breeding will be fed.

This study was conducted to determine the effect of breed and level of winter supplement intake of the dam on subsequent feedlot performance and carcass merit of the offpsring.

CHAPTER II

LITERATURE REVIEW

Little information has been accumulated on the feedlot performance and carcass characteristics of animals of 50 and 25 percent dairy breeding. In the few studies reported, the percentage dairy bred animals were fed to approximately the same slaughter weight or fed approximately equal time as the conventional beef breeds thus allowing limited conclusions on gain, or carcass traits. Most reports available are comparisons of straight Holstein and straight Hereford or Angus cattle. Therefore, this review will compare studies of straight Holstein versus calves of Angus and Hereford breeding. The information on 25 and 50 percent dairy breeding will be included and discussed.

Feedlot Performance

Early workers feeding straightbred Holstein and Angus steers concluded that Holstein steers gained faster than Angus steers in feeding periods of equal length (Bohstedt, 1922; Fuller, 1927; Fuller and Roche, 1929). Cole *et al.* (1964) comparing 100 percent British, Zebu and dairy bred steers also found Holstein steers to be superior in average daily gain when fed to a comparable slaughter weight of that for the British bred calves (Angus and Hereford). These findings are in agreement with those of other workers feeding animals to comparable slaughter weights (Hanke *et al.*, 1964; Minish *et al.*, 1966; Burroughs *et al.*, 1965). Larson *et al.* (1966) found average daily gain differences between Hereford and Holstein steers decreased as each group was fed to a heavier slaughter weight from 482 to 525 and 504 to 534 kilograms for the Hereford and Holstein groups, respectively.

Patterson *et al.* (1972) studied steer calves out of Hereford and Brown Swiss bulls and Hereford females, found average daily gain to be the similar for the 100 percent Hereford and the 50 percent Hereford, 50 percent Brown Swiss calves.

Branaman and Brown (1936, 1937) in their work with Hereford, Shorthorn and Holstein calves found Holsteins to require a greater amount of feed per kilogram of gain than the Hereford and Shorthorn calves. This agrees with work by other workers comparing Holstein and British beef breeds, with the Holstein calves requiring more feed per unit gain in each case (Hanke *et al.*, 1964; Larson *et al.*, 1966; Burroughs *et al.*, 1965). In addition, Garrett (1969) when feeding Hereford and Holstein calves to a comparable slaughter weight (411.8 and 391.8 kilograms respectively for Herefords and Holsteins) found Herefords to have a lower feed to weight gain ratio than Holstein calves. Patterson *et al.* (1972) found straight bred Hereford calves to be more efficient than Hereford X Brown Swiss calves slaughtered at 429 and 447 kilograms

In contrast to efficiencies already mentioned, studies by Cole *et al.* (1967) with Holsteins, Herefords and Angus found Holsteins to require approximately 0.5 kilograms less feed per unit gain than did Hereford and Angus calves. Burroughs *et al.* (1963) in a feeding trial with yearling Hereford and Holstein steers also found Holsteins to require less feed per unit gain; however, in a subsequent experiment utilizing the same age cattle but feeding them 38 days longer, Burroughs found the Holsteins to require more feed per kilogram gain.

Although there is conflicting information concerning feed efficiency, the majority of work published found dairy bred calves to be less efficient in conversion of feed to weight gain.

Days to reach a quality grade of low choice is difficult to ascertain as all literature deals with comparisons in which calves were fed approximately equal periods of time or to a constant slaughter weight. Cole _et al._ (1964) fed Holsteins 294 days with these calves' marbling score being traces (ave. standard), he also fed Angus and Hereford calves 310 and 315 days respectively with these cattle having marbling scores of small and moderate. So, from these data the Holstein breed would seem to need a longer feeding period to reach choice marbling. Hanke _et al._ (1964) feeding Holstein, Hereford and Shorthorn steers for a constant length of time (258 days) found Holstein steers to be lower in marbling score thus indicating a longer feeding period would have been needed for Holstein to reach the low choice quality grade.

Carcass Characteristics

Ziegler _et al._ (1971) found calves sired by Angus, Hereford, Polled Hereford and Charolais bulls and out of crossbred Angus X Holstein dams, fed _ad libitium_ a high energy ration, and slaughtered at unshrunk weights of 476 and 431 kilograms for the steers and heifers respectively, were as high or higher in quality grade than calves of straight breeding of the breeds used for production of crossbred calves. In all cross combinations, a quality grade of low choice was attained, and therefore the inclusion of 25 percent dairy breeding did not decrease final quality grade.

In comparisons between Hereford and Hereford X Brown Swiss fed to approximately the same slaughter weight, Patterson et al. (1972) found carcass quality grade to be higher for the straight Hereford calves over the calves with 50 percent dairy breeding. Work by Cole et al. (1964) found straight bred Holstein steers to be lower in final quality grade than Hereford or Angus steers when these calves were fed to approximately equal slaughter weights. Other workers feeding Holstein and British breeds of cattle have also found Holsteins to be lower in quality grade when fed to a slaughter weight approximately equal to that of the smaller, lighter maturing British breeds (Branaman et al., 1936; Minish et al., 1966; Garret, 1969). In these reports Holsteins were lower in marbling score and conformation score, two major contributors to quality. However, Larson et al. (1966), feeding Herefords and Holsteins to 1063 and 1158 lb. final weights for the Herefords and 1112 and 1178 lb. final weights for the Holsteins, found the Holsteins had more marbling at the lighter weights for the two breeds and also at the heavier weight comparison. However, due to lower conformation score for the Holsteins their final quality grade was lower than that of the Herefords.

The previous work indicates that the main determinant to final quality grade of the 100 percent dairy bred animals was their lower conformation score. However, 25 percent dairy breeding was infused with minimum effect on final quality grade. Marbling score seemed to be improved with the attaining of heavier slaughter weights in the straight bred Holstein calves.

Rib eye area was found to be larger for Hereford and Angus steers than Holstein steers when fed to slaughter weights of approximately 410 kilograms (Cole et al., 1963). This is in agreement with work by other workers feeding Hereford, Angus and Holstein to a slaughter weight of less than 450 kilograms (Wellington, 1971; Minish et al., 1966; Judge et al., 1965). At heavier carcass weights, neither the Holstein nor the Hereford and Angus maintained an advantage in rib eye area (Minish et al., 1965; Burroughs et al., 1963, 1964, 1965; Hanke et al., 1964).

Judge et al. (1965) found Angus steers to have more rib eye per kilogram of carcass weight than Holstein steers. This is in agreement with calculations from the data of Minish et al. (1966), Cole et al. (1964) and Carrol et al. (1962).

In comparisons in which Holsteins were compared with British beef breeds, Holsteins had less fat measured at the 12-13th rib separation (Cole et al., 1964; Hanke et al., 1964; Minish et al., 1966; Burroughs et al., 1965; Judge et al., 1965; Wellington, 1971). When fed to approximately equal slaughter weights, Brown Swiss X Hereford steers were found to have less rib fat than straight Hereford steers at comparable carcass weights (Patterson et al., 1972).

Calves of smaller dairy breeds tend to be higher in kidney, heart and pelvic fat (Cole et al., 1964; Kunkle and Cahill, 1959) but the literature indicates no difference in kidney fat between large dairy breeds and beef breeds (Cole et al., 1964; Minish et al., 1966; Larson et al., 1966).

Ziegler et al. (1971) found steers out of Angus X Holstein females and sired by Angus and Hereford bulls were higher in percent cutability than straight Hereford or Angus steers. Straight Holstein steer calves were essentially the same in cutability as the calves with 25 percent Holstein breeding. Patterson et al. (1972) found Brown Swiss X Hereford calves to be higher in yield grade than straight Hereford calves at comparable carcass weights. Yield grade or cutability percent is influenced highly by unit of fat measured at the 12-13th rib separation. In most studies, Holstein groups had less fat over the rib, therefore allowing a higher yield of retial cuts (Hanke et al., 1964; Larson et al., 1966; Minish et al., 1966; Burroughs et al., 1965).

Cole et al. (1964) and Callow (1961) found Holstein steers of comparable slaughter weight were higher in percent separable muscle and bone but lower in separable fat than straight Hereford calves. Branaman et al. (1962) found Holstein steers higher in separable bone than beef calves but differences in separable fat and lean were not significant.

Ziegler et al. (1971) found 25 percent dairy breeding did not significantly decrease tenderness as measured by Warner-Bratzler shear when compared to straight Hereford and Angus. He did find straight Holstein steers were less tender than Hereford and Angus steers. This is in agreement with work by Patterson et al. (1972) who found that Hereford X Brown Swiss steers were less tender than Hereford steers. Most workers have reported that straight Holsteins were similar to British breeds in tenderness as measured by the Warner-Bratzler shear (Branaman et al., 1962; Cole et al., 1964).

Carroll et al. (1962) found Holsteins to be higher in ether extract in the rib eye than Herefords of comparable carcass quality. Judge et al. (1965) found Holstein calves were higher in protein in fat-free rib eye muscle but similar in moisture content when compared to straight Angus calves.

CHAPTER III

THE EFFECTS OF BREED AND WINTER SUPPLEMENT LEVEL OF COWS ON FEEDLOT PERFORMANCE OF THEIR PROGENY[1,2]

Summary

The effects of breed of dam and level of winter supplementation on subsequent postweaning feedlot performance of 213 calves out of Hereford, Hereford X Holstein (Crossbred), and Holstein cows were determined. Calves, fed in two succeeding years, were sired by Angus (trial 1) and Charolais (trial 2) bulls. In each trial, one set of calves which had been reared on range preweaning was group fed and one set which had been reared in drylot preweaning was individually fed.

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Feedlot performance was generally not affected by level of supplement received by the dam. In breed comparisons, calves out of Holstein dams were heavier at entry and slaughter than calves out of Hereford dams. Calves out of Crossbred dams were intermediate for these traits. Calves out of Holstein dams had larger skeletal size, required a longer feeding period and were older at slaughter than calves out of Hereford dams; calves out of Crossbred dams tended to be more similar to calves out of Hereford dams.

Calves with Hereford dams gained faster and more efficiently than calves with Holstein dams. Calves with Crossbred dams gained as rapidly as calves out of Hereford dams, but were intermediate in feed efficiency.

Introduction

Infusion of Holstein breeding into a cow herd will increase weaning weight and possibly facilitate the utilization of a cheaper feed source (roughage) to produce a higher percentage of the final slaughter weight. The relative feedlot performance of calves with a percentage of dairy breeding is an important consideration. When fed equal time or to equal weight, straight-bred dairy calves gained faster but slightly less efficiently than straight-bred calves of the British breeds (Hanke *et al.*, 1964; Burroughs *et al.*, 1965; Minish, Newland and Henderson, 1966; Larson, Embry and Nygaard, 1966. Comparisons between beef and beef x dairy calves when fed to similar slaughter grade have not been reported.

The objective of the research reported herein was to determine the feedlot performance of calves with 0, 25 and 50% Holstein breeding when fed to equal slaughter grade.

Materials and Methods

The feedlot performance of calves differing in percentage of Holstein breeding (0, 25 or 50%) was determined at the Fort Reno Livestock Research Station. The calves were the first (trial 1) and second (trial 2) calves out of Hereford, Hereford X Holstein (Crossbred) and Holstein females; first and second calves were sired by Angus and Charolais bulls, respectively. One group of cows and calves was maintained on native range and another group was completely confined in drylot during each year. Within both range and drylot phases in each trial, two levels of winter supplement (Moderate and High) were fed to groups of cows within each breed; an additional supplement level (Very High) was fed only to a group of Holstein cows. Consequently, the calves were produced in seven breed-level of supplement groups. Calves were born in December, January and February. Those in drylot received creep feed, but those in the range phase did not. Each calf was weaned at 240$\pm$7 days. Detailed descriptions of management practices and data collected were reported by Kropp *et al.* (1973) and Holloway *et al.* (1973) who summarized the production of these females as 2- and 3-year olds, respectively.

At weaning, calves were shrunk for 12 hours before being weighed, photographed, and vaccinated for blackleg, PI3 and IBR. Actual weaning weight was used as the initial feedlot weight since calves were placed on feed immediately after weaning. Calves from the range cows were group fed as steer or heifer groups within their dams' breed and treatment group. Group fed calves were housed in a shed open to the south with access to outside pens in trial 1, whereas in trial 2 they were fed in outside pens with no shelter. Calves were self-fed and hand-fed twice daily in trials 1 and 2, respectively. Calves reared in drylot were individually self-fed postweaning in box stalls in a shed with one open side. The calves were confined to the box stalls from 4:00 pm to 8:00 am and placed in an outside loafing pen from 8:00 am to 4:00 pm.

One ration (table 1) was used for the entire feeding period in trial 1 and for group fed calves in trial 2. In an effort to improve performance, a ration higher in energy (table 2) was used for the individually fed calves in trial 2.

Each calf was fed to an estimated quality grade of low choice based on apparent fatness. Calves were shrunk for 12 hours, then weighed and photographed.

Skeletal size was determined from 8 x 10 inch (20.3 x 25.4 cm) photographs taken with the calf behind a grid at the beginning and end of the feeding period. Skeletal size was characterized by height, which was the distance from hook (tuber coxae) to the floor, and length which was the horizontal distance from point of shoulder (dorsal anterior humerous) to hook (tuber coxae). Before calves were photographed skeletal reference points (tuber coxae and dorsal anterior humerous) were marked with chalk to facilitate more accurate photographic body measurements.

A least squares analysis was employed using three breeds (Hereford, Crossbred and Holstein) and two levels of supplement (Moderate and High). An F test from this analysis was used to determine breed and supplement level of dam effects and interaction between

TABLE 1

RATION FOR TRIAL 1 AND FOR GROUP FED CALVES IN TRIAL 2

Ingredient	Amount
Milo, dry rolled, %	65.5
Cottonseed hulls, %	10.0
Chopped alfalfa hay, %	10.0
Soybean meal (44% CP), %	7.5
Urea (45% N), %	1.0
Liquid cane molasses, %	5.0
Dicalcium phosphate, %	0.5
NaCl, %	0.5
Vitamin A, IU/kg	10.0
Chlortetracycline, mg/kg	1.5
Stilbesterol[a], mg/kg	0.1

[a]Included in the ration only in trial 1.

TABLE 2

RATION FOR INDIVIDUALLY FED
CALVES IN TRIAL 2

Ingredient	Amount
Whole corn, %	87.0
Cottonseed hulls, %	5.0
Supplement (pelleted), %	8.0
Composition of supplement	
Soybean meal (44% CP), %	50.0
Cottonseed meal (41% CP), %	19.8
Wheat midds (15.5% CP), %	3.5
Urea (45% N), %	10.0
NaCl, %	4.5
KCl, %	3.3
$CaCO_3$ (38% Ca), %	7.5
Trace Mineral, %	.4
Vitamin A IU/kg	3400.0
Chlortetracycline mg/kg	105.0

breed, level of supplement and sex; Very High Holsteins were excluded from this analysis to allow a balanced 2x3x2 arrangement of breed, supplement level of dam and sex. Therefore, any mention of breed supplement level groups refers to these least squares means. Since significant sex x supplement level, sex x breed, and sex x supplement level x breed interactions were not found ($P>.05$), another least squares analysis was conducted with all breed-supplement level combinations to obtain a sex-adjusted least squares mean. An analysis of variance was then calculated with all breed-supplement level combinations included in a simple one-way classification with this combination being the classification factor. The error mean square associated with this analysis was used to calculate a Least Significant Difference (Snedecor and Cochran, 1967) which was employed in comparing the Very High to other breed-supplement level groups.

Results and Discussion

Level of Supplement Comparisons

Tables presenting means by breed and supplement level of the dam are given in tables 3 and 4 for trial 1, for group and individually fed calves, and in table 5 and 6 for trial 2 for group and individually fed calves, respectively.

Average daily gain for group-fed calves in trial 1 was significantly ($P<.05$) decreased with increased level of supplement intake by the dam; this effect on average daily gain was not noted in trial 1 individually fed calves or in trial 2 ($P>.05$). In the individually fed calves in trial 2, entry length, slaughter length and slaughter weight were significantly ($P<.05$) affected by supplement level of the dam.

TABLE 3

LEAST SQUARES MEANS AND STANDARD DEVIATIONS FOR FEEDLOT PERFORMANCE OF TRIAL 1 GROUP FED CALVES

	Breed of dam and supplement level							
	Hereford		Hereford x Holstein		Holstein			
Item	Moderate	High	Moderate	High	Moderate	High	Very High	SD
No. of head	12	13	13	13	11	11	12	
Initial wt., kg[a]	233[b]	218[b]	244[c]	246[c]	266[d]	272[d]	277[d]	22.2
Slaughter wt., kg	409[b]	387[b]	443[c]	447[c]	495[d]	491[d]	503[d]	33.6
Age at slaughter, days[f]	381[b]	381[b]	394[b]	395[b]	418[c]	433[c]	442[c]	28.2
Days fed	141[b]	141[b]	154[b]	155[b]	178[c]	193[c]	202[c]	28.2
Daily gain, kg	1.36[c]	1.23[b]	1.31[bc]	1.29[bc]	1.30[bc]	1.16[b]	1.10[b]	0.14
Kg feed/kg gain	7.52	7.74	7.74	7.54	8.76	9.11	9.06	
Skeletal Size								
Initial height, cm	96.4[bc]	93.9[b]	99.9[d]	98.3[cd]	103.6[e]	104.4[e]	105.7[e]	3.9
Initial length, cm	70.2[b]	67.5[b]	70.3[b]	71.5[b]	74.2[c]	74.0[c]	74.7[c]	4.8
Slaughter height, cm	104.4[b]	101.1[b]	105.1[b]	108.5[b]	114.0[c]	115.3[c]	115.4[c]	5.3
Slaughter length, cm	77.0[b]	75.7[b]	82.8[c]	78.3[b]	83.5[c]	84.9[c]	86.7[c]	6.1

[a]Actual weaning weight.

[bcde]Means on the same line with the same superscript letter are not significantly different (P .05).

[f]240 days + average days fed.

[g]Simple average of steer and heifer pen means.

TABLE 4

LEAST SQUARES MEANS AND STANDARD DEVIATIONS
FOR FEEDLOT PERFORMANCE OF TRIAL 1
INDIVIDUALLY FED CALVES

	Breed of dam and supplement level							
	Hereford		Hereford x Holstein		Holstein			
Item	Moderate	High	Moderate	High	Moderate	High	Very High	SD
No. of head	5	4	4	5	4	5	5	
Initial wt., kg[a]	170^{b}	189^{b}	227^{c}	223^{c}	235^{cd}	244^{cd}	258^{d}	19.7
Slaughter wt., kg	402^{b}	404^{b}	469^{cd}	458^{c}	489^{cd}	521^{d}	503^{cd}	39.0
Age at slaughter, days[e]	445^{bc}	421^{b}	468^{bcd}	460^{bcd}	499^{d}	493^{d}	482^{cd}	36.0
Days fed	205^{bc}	181^{b}	228^{bcd}	220^{bcd}	259^{d}	253^{d}	242^{cd}	36.0
Daily gain, kg	1.13^{bc}	1.17^{c}	1.06^{bc}	1.07^{bc}	1.01^{b}	1.11^{bc}	1.00^{b}	0.13
Kg feed/kg gain	7.23^{b}	7.36^{b}	8.96^{c}	8.62^{c}	9.30^{c}	9.57^{c}	9.60^{c}	
Skeletal Size								
Initial height, cm	93.9^{b}	93.2^{b}	100.0^{c}	100.0^{c}	104.4^{d}	118.7^{d}	103.3^{d}	2.5
Initial length, cm	62.1^{b}	64.0^{b}	68.1^{bc}	74.2^{c}	74.2^{c}	72.1^{c}	73.3^{c}	4.9
Slaughter height, cm	109.2^{bc}	106.6^{b}	113.4^{c}	112.0^{c}	115.8^{cd}	116.1^{cd}	117.9^{d}	3.5
Slaughter length, cm	78.5^{b}	74.6^{b}	85.5^{c}	81.8^{bc}	82.5^{c}	88.6^{c}	84.1^{c}	6.0

[a]Actual weaning weight.

[bcd]Means on the same line with the same superscript letter are not significantly different (P .05).

[e]240 days + average days fed.

TABLE 5

LEAST SQUARES MEANS AND STANDARD DEVIATIONS
FOR FEEDLOT PERFORMANCE OF TRIAL 2
GROUP FED CALVES

	Breed of dam and supplement level							
	Hereford		Hereford x Holstein		Holstein			
Item	Moderate	High	Moderate	High	Moderate	High	Very High	SD
No. of head	13	11	8	11	3	8	8	
Initial wt., kg[a]	258^{b}	259^{b}	281^{c}	283^{c}	326^{d}	325^{d}	326^{d}	21.4
Slaughter wt., kg	452^{b}	447^{b}	483^{c}	471^{bc}	523^{d}	545^{d}	530^{d}	36.8
Age at slaughter, days[e]	425^{b}	429^{b}	451^{bc}	445^{bc}	438^{bc}	472^{c}	483^{c}	33.2
Days fed	185^{b}	189^{b}	211^{bc}	205^{bc}	198^{bc}	232^{c}	254^{c}	33.2
Daily gain, kg	1.05^{c}	1.00^{bc}	0.99^{bc}	0.94^{bc}	1.06^{c}	0.94^{bc}	0.85^{b}	0.18
Kg feed/kg gain	9.87	10.24	10.91	10.72	13.50	12.36	13.43	
Skeletal Size								
Initial height, cm	104.6^{b}	103.5^{b}	104.7^{b}	104.8^{b}	107.5^{b}	110.0^{c}	109.1^{c}	4.9
Initial length, cm	70.9^{b}	70.6^{b}	73.6^{b}	74.7^{b}	75.7^{b}	81.4^{c}	79.2^{c}	4.7
Slaughter height, cm	113.2^{b}	114.2^{b}	114.2^{b}	113.7^{b}	125.0^{c}	123.4^{c}	123.4^{c}	5.0
Slaughter length, cm	82.0^{b}	81.6^{b}	83.5^{b}	86.6^{bc}	97.8^{d}	90.5^{cd}	90.2^{cd}	6.1

[a]Actual weaning weight.

[bcd]Means on the same line with the same superscript letter are not significantly different (P .05).

[e]240 days + average days fed.

[f]Simple average of steer and heifer pen averages.

TABLE 6

LEAST SQUARES MEANS AND STANDARD DEVIATIONS FOR FEEDLOT PERFORMANCE OF TRIAL 2 INDIVIDUALLY FED CALVES

	Breed of dam and supplement level							
	Hereford		Hereford x Holstein		Holstein			
Item	Moderate	High	Moderate	High	Moderate	High	Very High	SD
No. of head	5	5	5	5	5	4	5	
Initial wt., kg[a]	229^{b}	239^{b}	231^{b}	299^{c}	297^{c}	307^{c}	298^{c}	29.4
Slaughter wt., kg	427^{b}	477^{bc}	417^{b}	531^{c}	510^{c}	526^{c}	520^{c}	59.8
Age at slaughter, days[f]	429^{b}	458^{b}	425^{b}	468^{bc}	491^{c}	479^{c}	487^{c}	25.5
Days fed	189^{b}	218^{b}	185^{b}	228^{bc}	251^{c}	239^{c}	247^{c}	25.5
Daily gain, kg	1.06^{bc}	1.10^{c}	1.01^{bc}	1.03^{bc}	0.85^{b}	0.91^{bc}	0.90^{bc}	0.16
Kg feed/kg gain	7.82^{b}	7.35^{b}	7.99^{bc}	8.45^{bc}	10.05^{d}	10.22^{d}	9.94^{cd}	0.97
Skeletal Size								
Initial height, cm	103.9^{b}	105.7^{b}	105.1^{b}	108.5^{bc}	112.6^{cd}	114.9^{d}	110.9^{cd}	3.7
Initial length, cm	68.1^{b}	74.2^{bc}	68.0^{b}	78.0^{c}	72.2^{bc}	77.8^{c}	77.2^{c}	5.6
Slaughter height, cm	111.0^{bc}	115.1^{cd}	108.7^{b}	118.0^{d}	125.9^{e}	124.5^{e}	121.2^{e}	4.7
Slaughter length, cm	78.2^{b}	82.3^{b}	80.4^{b}	90.2^{cd}	92.5^{d}	96.2^{d}	89.6^{cd}	5.8

[a] Actual weaning weight.

[bcde] Means on the same line with the same superscript letter are not significantly different (P .05).

[f] 240 days + average days fed.

These data suggest little evidence for an effect of level of winter supplement of the dam on the postweaning feedlot performance of progeny. Since very few of the large number of variables analyzed in the two trials were significantly affected by supplement level of dam, it is likely they represented random chance rather than a real treatment effect. These results are not surprising since in almost every comparison initial weight (weaning weight) within breed of dam was not affected ($P > .05$) by level of supplement of the dam.

Breed Comparisons

Tables 7, 8, 9 and 10 present means for calves by breed of dam (Hereford, Crossbred and Holstein). These means are weighted averages of the least squares treatment means presented in tables 3 to 6; standard deviations are the same as those given in breed-supplement level tables and were obtained from error mean squares associated with the analysis of variance utilizing the seven breed-supplement level combinations

Initial Weight. Calves with Crossbred dams were significantly ($P < .05$) heavier at entry than calves with Hereford dams in every comparison; differences ranged from 50 to 101 lb. Calves with Holstein dams were significantly ($P < .05$) heavier at entry than calves out of both Hereford and Crossbred dams in all four comparisons; the advantage over Crossbred dams ranged from 48 to 95 lb.

Slaughter Weight. Slaughter weight followed the same pattern as initial weight, but breed of dam differences were larger at slaughter. Calves out of Crossbred dams were 49 to 123 lb. heavier at slaughter than calves out of Hereford dams; differences were significant ($P < .05$)

TABLE 7

BREED MEANS AND STANDARD DEVIATIONS FOR FEEDLOT PERFORMANCE OF TRIAL 1 GROUP FED CALVES

Item	Breed of dam			SD
	Hereford	Hereford x Holstein	Holstein	
No. of head	25	26	34	
Initial wt., kg[a]	225[b]	245[c]	272[d]	22.2
Slaughter wt., kg	298[b]	445[c]	496[d]	33.6
Age at slaughter, days[e]	381[b]	395[b]	432[c]	28.2
Days fed	141[b]	155[b]	192[c]	28.2
Daily gain, kg	1.29[b]	1.30[b]	1.18[c]	0.14
Kg feed/kg gain	7.30[a]	8.79[b]	9.39[b]	0.98
Skeletal Size				
Initial height, cm	95.1[b]	99.1[c]	104.6[d]	3.9
Initial length, cm	68.8[b]	70.9[b]	74.3[c]	4.8
Slaughter height, cm	102.7[b]	106.8[c]	114.9[d]	5.3
Slaughter length, cm	76.3[b]	80.6[c]	85.1[d]	6.1

[a]Actual weaning weight.

[bcd]Means on the same line with the same superscript letter are not significantly different (P>.05).

[e]240 days + average days fed.

[f]Simple average of steer and heifer pen averages.

TABLE 8

BREED MEANS AND STANDARD DEVIATIONS FOR FEEDLOT PERFORMANCE OF TRIAL 1 INDIVIDUALLY FED CALVES

Item	Breed of dam			SD
	Hereford	Hereford x Holstein	Holstein	
No. of head	9	9	14	
Initial wt., kg[a]	179[b]	225[c]	247[d]	19.7
Slaughter wt., kg	403[b]	463[c]	505[d]	39.0
Age at slaughter, days[e]	434[b]	463[c]	491[d]	36.0
Days fed	194[b]	223[c]	251[d]	36.0
Daily gain, kg	1.15[b]	1.07[bc]	1.04[c]	0.13
Kg feed/kg gain	7.29[b]	8.77[c]	9.50[c]	0.82
Skeletal Size				
Initial height, cm	93.6[b]	100.0[c]	109.1[d]	2.5
Initial length, cm	62.9[b]	71.5[c]	73.1[c]	4.9
Slaughter height, cm	108.0[b]	112.6[c]	116.7[d]	3.5
Slaughter length, cm	76.8[b]	83.4[c]	85.2[c]	6.0

[a]Actual weaning weight.

[bcd]Means on the same line with the same superscript letter are not significantly different ($P > .05$).

[e]240 days + average days fed.

TABLE 9

BREED MEANS AND STANDARD DEVIATIONS FOR FEEDLOT PERFORMANCE OF TRIAL 2 GROUP FED CALVES

	Breed of dam			
Item	Hereford	Hereford x Holstein	Holstein	SD
No. of head	24	19	19	
Initial wt., kg[a]	259[b]	282[c]	325[d]	21.4
Slaughter wt., kg	450[b]	476[c]	535[d]	36.8
Age at slaughter, days[e]	427[b]	447[c]	472[d]	33.2
Days fed	187[b]	207[c]	232[d]	33.2
Daily gain, kg	1.02[b]	0.96[bc]	0.92[c]	0.18
Kg feed/kg gain	10.04	10.8	12.99	
Skeletal Size				
Initial height, cm	104.1[b]	104.8[b]	109.2[c]	4.9
Initial length, cm	70.8[b]	74.2[c]	79.6[d]	4.7
Slaughter height, cm	113.7[b]	113.9[b]	123.6[c]	5.0
Slaughter length, cm	81.8[b]	85.3[c]	91.5[d]	6.1

[a]Actual weaning weight.

[bcd]Means on the same line with the same superscript letter are not significantly different (P>.05).

[e]240 days + average days fed.

[f]Simple average of steer and heifer pen averages.

TABLE 10

BREED MEANS AND STANDARD DEVIATIONS FOR FEEDLOT PERFORMANCE OF TRIAL 2 INDIVIDUALLY FED CALVES

	Breed of dam			
Item	Hereford	Hereford x Holstein	Holstein	SD
No. of head	10	10	14	
Initial wt., kg[a]	234[b]	265[c]	300[c]	29.4
Slaughter wt., kg	452[b]	474[bc]	518[c]	59.8
Age at slaughter, days[e]	443[b]	446[b]	485[c]	25.5
Days fed	203[b]	206[b]	246[c]	
Daily gain, kg	1.08[b]	1.02[b]	0.88[c]	0.16
Kg feed/kg gain	7.62[b]	8.18[b]	10.07[c]	0.97
Skeletal Size				
Initial height, cm	104.8[b]	106.8[b]	112.7[c]	3.7
Initial length, cm	71.7[b]	73.0[b]	75.6[b]	5.6
Slaughter height, cm	113.1[b]	113.4[b]	123.8[c]	4.7
Slaughter length, cm	80.3[b]	85.3[b]	92.5[c]	5.8

[a]Actual weaning weight.

[bcd]Means on the same line with the same superscript letter are not significantly different (P>.05).

[e]240 days + average days fed.

in three of four comparisons. Calves out of Holstein dams were 92 to 130 lb. heavier than calves out of Crossbred dams; differences again were significant ($P < .05$) in three of four comparisons.

Age at Slaughter. Calves out of Hereford dams were youngest and those out of Holstein dams were oldest at slaughter in every comparison. The additional age of Crossbred progeny compared to Hereford progeny (3 to 29 days) was significant ($P < .05$) in two of four comparisons. The additional age of Holstein progeny compared to Crossbred progeny (25 to 39 days) was significant ($P < .05$) in every comparison.

Days Fed. Since age at slaughter was calculated by using days fed plus 240 days, differences in days fed and differences in age were the same; results of statistical analyses were also the same. Calves out of Hereford dams required the shortest feeding period (141 to 203 days) to reach anticipated quality grade of low choice, followed by calves out of Crossbred dams (155 to 223 days) and calves out of Holstein dams (192 to 251 days).

Daily Gain. Hereford progeny gained significantly (P .05) faster than Holstein progeny in every comparison. Hereford progeny also gained faster than Crossbred progeny in three of four comparisons, but differences in daily gain between Hereford and Crossbred progeny were not significant ($P > .05$). Crossbred progeny gained faster than Holstein progeny in all cases; differences were significant in two of four comparisons.

Feed Efficiency. Feed efficiency could be statistically analyzed only in those cases where calves were individually fed. In these two comparisons Hereford progeny was significantly ($P < .05$) more efficient than Holstein progeny. Crossbred progeny was intermediate, significantly ($P<.05$) less efficient than Hereford progeny, in one comparison and significantly ($P<.05$) more efficient than Holstein progeny in the other comparison.

The same trend was observed in the group fed comparisons with Hereford progeny most efficient and Holstein progeny least efficient. However, efficiency of Crossbred progeny was closer to that of Hereford progeny, being almost identical in one comparison.

The breed of dam differences in feed efficiency were quite large. In the four comparisons, feed required per unit gain was 1, 21, 7 and 22% greater for Crossbreds than Herefords and 18, 32, 28 and 32% greater for Holsteins than Herefords.

Skeletal Size. Initial skeletal measurements (at weaning) indicated calves out of Holstein dams were significantly ($P<.05$) larger than calves out of Hereford dams except for length of body in trial 2 individually fed calves; the trend in this case was the same. Calves out of Crossbred dams were intermediate in length and/or height in each comparison, but tended to be closer in size to calves out of Hereford dams.

Measurements at slaughter indicated calves out of Holstein dams were significantly ($P<.05$) larger than calves out of Hereford dams in all comparisons. Calves out of Crossbred dams tended to be intermediate, although in trial 2 Crossbred progeny was similar in height to Hereford progeny.

Discussion

The increase in initial weight (weaning weight) with increasing increments of Holstein breeding followed an expected pattern.

Crossbred and Holstein progeny received approximately 50 and 100% more milk than Hereford progeny, respectively, during the preweaning nursing period (Kropp et al., 1973; Holloway et al., 1973). In addition, calves increased in skeletal size with each increment of Holstein breeding, consistent with the greater mature size of Holsteins compared to Herefords.

The increased slaughter weight of Crossbred and Holstein progeny is also consistent with their heavier initial weight as well as the increase in length of feeding period required to reach choice grade observed for each increment of Holstein breeding. The increase in required length of feeding period (and age at slaughter) for each increment of Holstein breeding in turn is consistent with greater skeletal size of progeny at slaughter as a reflection of larger mature size of Holsteins. The validity of required length of feeding period comparisons in these trials is enhanced by the fact that carcass grade was not affected ($P > .05$) by breed of dam (Dean et al., 1973).

The decrease in daily gain with increasing increments of Holstein breeding observed in these trials may be surprising since in previous comparisons straight-bred Holsteins have outgained straight-bred British breeds (Bohstedt, 1922; Fuller, 1927; Fuller and Roche, 1929; Cole et al., 1964; Hanke et al., 1964; Burroughs et al., 1965; Minish et al., 1966). These differing results can probably be explained by differences in age and fatness of calves at the beginning of the feeding period. In these trials calves were placed on feed at weaning and were comparable in age and fatness whereas in previous research, Holsteins were usually obtained on the open market. Holsteins and Holstein crossbreds available in market channels are normally relatively large framed and thin, and would be expected to achieve large compensatory gains.

Observations regarding feed efficiency in these trials are consistent with previous reports that Holsteins required more feed per unit of gain than British breeds (Branaman et al., 1962; Hanke et al., 1964; Burroughs et al., 1965; Larson et al., 1966; Garrett, 1969). The larger differences observed in these trials can probably be attributed to the lack of compensatory gain, as previously hypothesized relative to rate of gain.

Results of these trials provide necessary input data to calculate various economic interpretations relative to the breeds of cattle used herein. These economic interpretations could include costs and returns at current prices, and the relative value of the indicated breeds for feeding at assumed prices for other inputs and slaughter cattle.

CHAPTER IV

THE EFFECTS OF BREED AND WINTER SUPPLEMENT LEVEL OF COWS ON CARCASS CHARACTERISTICS OF THEIR PROGENY[1,2]

Summary

The effect of winter supplement level and breed of dam on carcass characteristics of 213 calves out of Hereford, Hereford X Holstein and Holstein females and sired by Angus (trial 1) and Charolais (trial 2) bulls were studied. In each trial, one set of calves was group fed and one set was individually fed.

The effect of dams' winter supplement intake on carcass traits was not a major source of variation in the majority of traits studied

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in the two years. Differences in kidney, heart and pelvic fat and conformation score in trial 1 group fed calves and differences in quality grade in trial 2 individually fed calves were found to be significantly different ($P<.05$) due to treatment. Since very few traits were significantly affected by treatment of dam, it was concluded that treatment of dam had no major influence on carcass characteristics.

Carcass weight was heaviest for calves out of Holstein dams, followed by calves out of Crossbred dams, in all comparisons. Carcass weight per day of age was significantly ($P<.05$) more for calves out of Holstein cows than for calves out of Hereford cows in all cases except trial 1 individually fed calves. Calves with Crossbred dams were lower in carcass weight/day of age than calves with Holstein dams in group fed calves both years.

Rib eye area was increased with increasing levels of Holstein breeding; however, rib eye per 100 kg carcass was significantly ($P<.05$) more for calves out of Hereford dams. Calves out of Holstein dams had less fat over the eye per 100 kg carcass and less kidney, heart and pelvic fat per 100 kg carcass than calves with Hereford dams. Difference in fat over the eye and KHP showed no significant trends. Cutability was not affected significantly ($P>.05$) by breed of dam.

Conformation grade was lowered in calves out of straight Holstein dams; calves out of Crossbred dams were comparable to calves with Hereford dams. Marbling score was higher for calves out of Holstein dams in all cases. Calves with Crossbred dams tended to be higher in marbling than calves out of Hereford dams. Quality grade was not significantly lowered by inclusion of increasing levels of Holstein breeding with increasing marbling compensating for lower conformation.

Warner-Bratzler shear and cooking loss were not affected by breed of dam. Calves out of Holstein dams were higher in dry matter and ether extract. Crude protein showed no significant trends for breed of dam.

Introduction

Because of the infusion of dairy breeding into beef-producing herds to increase weaning weight, more calves with some percentage of dairy breeding will be available for feeding and slaughter. Straight-bred Holstein cattle had less trimable fat (Cole et al., 1964; Judge et al., 1965; Wellington, 1971) put poorer carcass conformation and consequently lower carcass grade than straight-bred British cattle (Branaman et al., 1936; Cole et al., 1964; Minish et al., 1966). A smaller percentage (25%) of Holstein breeding did not decrease carcass grade compared to straight-bred British calves (Ziegler et al., 1971). In most comparisons involving beef versus Holstein Holstein cattle, cattle have been fed either on a time-constant basis or to a comparable slaughter weight; a more common practice in the industry is to feed to a slaughter grade of predominantly choice. The effects of a varying percentage of Holstein breeding on several carcass traits need to be determined.

The objective of the research reported herein was to compare the carcasses of calves of 0, 25 and 50% Holstein breeding with regard to a number of carcass traits after feeding to approximately equal slaughter grade.

Materials and Methods

Carcass characteristics of calves differing in percentage of Holstein breeding (0, 25 or 50%) were determined. Carcasses were obtained from the first and second calves of Hereford, Hereford X Holstein (Crossbred) and Holstein females; the first and second calves were sired by Angus (trial 1) and Charolais (trial 2) bulls, respectively. The dams of the calves were fed Moderate or High levels of winter supplement (Herefords, Crossbreds and Holsteins); a Very High level was fed only to Holsteins. Calves were reared to weaning under either native range or completely confined drylot conditions. Detailed description of management practices and data collected were reported by Kropp et al (1972) and Holloway et al. (1973). Management of calves while in the feedlot and data collected were reported by Dean et al. (1973). Only information specifically related to the research reported herein will be described in detail.

Calves reared on the range were group fed by sex of calf and supplement level of dam while those reared in drylot were individually fed. Calves were selected for slaughter as each reached an anticipated quality grade of low choice based on apparent fatness. Group fed calves were slaughtered in a federally inspected commercial slaughter plant in Oklahoma City; individually fed calves were slaughtered at the Oklahoma State University Meat Laboratory. Carcasses out of group fed calves were chilled 24 hours the first year and 72 hours the second year; a USDA grader subsequently estimated quality grade, marbling score, maturity, conformation score and kidney, heart and pelvic fat. Carcasses out of individually fed calves were chilled 72 hours both years and the same estimates were made by a staff member. A tracing was made at the 12th-13th rib separation on each carcass to determine rib eye area and fat thickness over the rib. Cutability was calculated as outlined by Murphey et al. (1960).

The wholesale rib from the left half of each carcass was obtained. Three steaks approximately 5.1 cm thick were removed from the posterior end of each rib. These steaks were designated A, B, or C (starting at the 12th rib) as they were removed and frozen for later evaluation.

Three 2.54 cm cores were removed from steak B after thawing 16 hours at 1.7C, mixed into a homogenous mixture using a Sorvall omnimixer with an icepack and placed in a plastic bag, frozen and stored. For chemical analysis, samples were thawed 12 hours and mixed to make a homogenous mixture. Duplicate 5 gm samples were dried at 100C for 16 hours for determination of dry matter, then analyzed for ether extract by the Soxlet method (A.O.A.C., 1965). Duplicate 1 gm aliquots were analyzed for crude protein by the Kjeldahl procedure.

Steak C was used for determination of Warner-Bratzler shear value and cooking loss. This steak was thawed at 1.7C for 36 hours, trimmed of all subcutanous fat and weighed. The steak was then deep-fat fried to an internal temperature of 150C, allowed to drain approximately 30 minutes and weighed again for a determination of cooking loss. Following a 24-hour chill in a 1.7C cooler, three 2.54 cm cores were taken from each steak; each of the three cores was then sheared three times, perpendicular to the meat fibers. The nine shear values thus obtained were averaged for each animal to yield a single value.

A least squares analysis was employed using three breeds (Hereford, Crossbred and Holstein) and two treatments (level of supplement of the dam, Moderate and High). An F test from this analysis was used to determine breed, supplement level and sex effects, and interactions; Very High Holsteins were excluded from this analysis to allow a balanced 2x3x2 arrangement of breed, supplement level and sex. Therefore, any reference to breed and supplement level means relates to these least squares means. Since significant (P .05) sex x supplement level, sex x breed, and sex x supplement level x breed interactions were not found, another least squares analysis was conducted with all breed-supplement level combinations to obtain a sex adjusted least squares mean. An analysis of variance was then calculated with all breed-supplement level combinations included in a simple one-way classification with this combination being the classification factor. The error mean square associated with this analysis was used to calculate a Least Significant Difference (Snedecor and Cochran, 1967) which was employed in comparing the Very High to other breed-supplement level groups.

Results and Discussion

Supplement Level of Dam

Breed and supplement level of dam means are given in tables 11 and 12 for trial 1 group and individually fed calves and in tables 13 and 14 for group and individually fed calves.

In trial 1 group fed calves (table 11), supplement level of dam caused a significant ($P \leqslant .05$) decrease in kidney, heart and pelfic fat and conformation score of progeny of dams fed the high level of winter supplement. These differences in KHP fat and conformation score have

TABLE 11

LEAST SQUARES MEANS AND STANDARD DEVIATIONS FOR CARCASS CHARACTERISTICS OF TRIAL 1 GROUP FED CALVES

	Breed of dam and supplement level							
	Hereford		Hereford x Holstein		Holstein			
Item	Moderate	High	Moderate	High	Moderate	High	Very High	SD
No. of head	12	13	13	13	11	11	12	
Hot carcass wt., kg	246^{a}	236^{a}	271^{b}	272^{b}	308^{c}	303^{c}	314^{c}	23.77
Carcass weight/day of age, kg	$.65^{ab}$	$.62^{a}$	$.69^{bc}$	$.69^{bc}$	$.74^{c}$	$.70^{c}$	$.71^{c}$	.05
Rib eye area, cm	73.6^{ab}	66.2^{a}	74.5^{ab}	73.3^{ab}	75.2^{b}	77.0^{bc}	81.0^{c}	6.84
REA/100 kg carcass, cm	29.9^{e}	28.1^{de}	27.5^{cd}	26.6^{bc}	24.4^{a}	25.3^{ab}	26.0^{abc}	2.42
Fat thickness[e], cm	2.0^{ab}	2.3^{cd}	2.2^{bcd}	2.5^{d}	2.3^{cd}	1.9^{a}	2.1^{abc}	.41
Fat thickness/100 kg[e] carcass, cm	$.82^{b}$	$.99^{d}$	$.81^{bc}$	$.95^{cd}$	$.73^{ab}$	$.62^{a}$	$.67^{a}$	.11
K, H, P Fat[f], %	3.26^{ab}	3.00^{a}	3.41^{bc}	3.33^{bc}	3.67^{c}	3.31^{ab}	3.40^{bc}	.39
K, H, P Fat/100 kg[f] carcass, %	1.34^{d}	1.27^{cd}	1.25^{cd}	1.23^{bcd}	1.19^{abc}	1.10^{a}	1.12^{ab}	.15
Cutability, %	48.6^{b}	47.5^{ab}	47.6^{ab}	46.8^{a}	46.7^{a}	48.1^{b}	47.8^{ab}	1.43
Conformation score[g]	11.5^{d}	10.8^{bc}	11.3^{cd}	10.8^{bc}	10.7^{bc}	9.7^{a}	10.0^{ab}	.82
Marbling score[h]	13.7^{ab}	13.2^{ab}	12.9^{a}	14.7^{abc}	16.5^{cd}	15.3^{bcd}	17.5^{d}	2.91
Carcass grade[g]	9.5^{a}	9.6^{a}	9.2^{a}	10.1^{abc}	10.6^{bc}	10.0^{ab}	10.9^{c}	1.13
Warner-Bratzler shear value[i], kg	9.3^{bc}	8.8^{abc}	9.6^{c}	8.9^{abc}	7.6^{a}	8.5^{abc}	7.8^{ab}	1.56
Cooking loss[j], %	33.4^{a}	31.1^{a}	33.0^{a}	33.0^{a}	32.4^{a}	34.2^{a}	32.4^{a}	3.44
Ether extract[k], %	5.4^{bc}	4.6^{ab}	3.9^{a}	5.4^{bc}	6.0^{c}	4.5^{ab}	6.4^{c}	1.40
Protein[k], %	21.0^{ab}	20.9^{ab}	20.5^{a}	20.8^{ab}	20.6^{a}	21.5^{b}	20.8^{a}	.79
Dry matter[k], %	28.2^{b}	27.6^{ab}	26.7^{a}	28.5^{bc}	28.8^{bc}	28.2^{bc}	29.2^{c}	1.48

[abc] Means on the same line with the same superscript letter are not significantly different (P .05).

[d] Average of three measurements taken 1/4, 1/2, 3/4 length of longissimus.

[e] Kidney, heart and pelvic fat.

[f] 9=High Good 10=Low Choice 11=Average Choice.

[g] Based on 30 point scale, 12=Slight+, 13=Small-, 14=Small, 15=Small+, 16=Modest-, 17=Modest.

[h] Mean of three 2.54 centimeter cores sheared 3 times each.

[i] Loss during deep frying of 5.09 cm trimmed steak.

[j] Composition of three 2.54 cm cores from longissimus.

TABLE 12

LEAST SQUARES MEANS AND STANDARD DEVIATIONS FOR CARCASS CHARACTERISTICS OF TRIAL 1 INDIVIDUALLY FED CALVES

	Breed of dam and supplement level							
	Hereford		Hereford x Holstein		Holstein			
Item	Moderate	High	Moderate	High	Moderate	High	Very High	SD
No. of head	5	4	4	5	4	5	5	
Hot carcass wt., kg	240^{a}	242^{ab}	285^{bcd}	277^{bc}	291^{cd}	314^{d}	312^{cd}	27.13
Carcass weight/day of age, kg	.57^{a}	.54^{a}	.61^{ab}	.60^{ab}	.59^{ab}	.64^{b}	.65^{b}	.05
Rib eye area, cm	75.7^{a}	80.0^{a}	83.7^{a}	73.7^{a}	75.6^{a}	76.5^{a}	73.9^{a}	8.90
REA/100 kg carcass, cm	31.5^{c}	33.1^{c}	29.4^{bc}	26.6^{ab}	26.0^{ab}	24.4^{a}	23.7^{a}	2.71
Fat thickness[e], cm	1.7^{a}	1.9^{a}	1.4^{a}	1.7^{a}	1.6^{a}	1.6^{a}	1.8^{a}	.38
Fat thickness/100 kg[e] carcass, cm	.71^{bc}	.79^{c}	.51^{ab}	.61^{abc}	.55^{ab}	.50^{a}	.58^{ab}	.15
K, H, P Fat[f], %	2.8^{a}	3.0^{a}	3.3^{a}	3.4^{a}	2.7^{a}	3.2^{a}	3.5^{a}	.67
K, H, P Fat/100 kg[f] carcass, %	1.17^{a}	1.24^{a}	1.16^{a}	1.23^{a}	.93^{a}	1.02^{a}	1.22^{a}	.26
Cutability, %	50.0^{a}	49.7^{a}	50.1^{a}	48.6^{a}	49.3^{a}	48.7^{a}	47.7^{a}	1.83
Conformation score[g]	10.3^{ab}	11.6^{b}	10.0^{ab}	9.6^{ab}	8.3^{a}	10.2^{ab}	9.1^{ab}	1.83
Marbling score[h]	12.5^{ab}	11.3^{ab}	13.4^{ab}	13.2^{ab}	10.1^{a}	14.2^{ab}	15.3^{b}	3.26
Carcass grade[g]	9.6^{ab}	9.2^{ab}	9.4^{ab}	9.9^{b}	7.9^{a}	9.5^{ab}	9.8^{ab}	1.40
Warner-Bratzler shear value[i], kg	8.1^{a}	7.7^{a}	7.7^{a}	7.5^{a}	8.7^{a}	6.7^{a}	7.4^{a}	1.70
Cooking loss[j], %	29.0^{a}	38.0^{a}	36.4^{a}	32.6^{a}	31.8^{a}	33.4^{a}	34.0^{a}	4.88
Ether extract[k], %	2.8^{a}	4.7^{a}	4.7^{a}	4.2^{a}	4.7^{a}	5.6^{a}	4.8^{a}	1.86
Protein[k], %	21.4^{cd}	21.3^{bcd}	21.9^{d}	21.3^{bcd}	20.4^{a}	20.7^{ab}	21.0^{abc}	.42
Dry matter[k], %	26.5^{a}	27.6^{ab}	28.3^{ab}	27.9^{ab}	28.6^{ab}	29.5^{b}	27.8^{a}	1.59

[abc]Means on the same line with the same superscript letter are not significantly different (P .05).

[d]Average of three measurements taken 1/4, 1/2, 3/4 length of longissimus.

[e]Kidney, heart and pelvic fat.

[f]9=High Good 10=Low Choice 11=Average Choice.

[g]Based on 30 point scale, 12=Slight, 13=Small-, 14=Small, 15=Small+, 16=Modest-, 17=Modest.

[h]Mean of three 2.54 centimeter cores sheared 3 times each.

[i]Loss during deep frying of 5.09 cm trimmed steak.

[j]Composition of three 2.54 cm cores from longissimus.

TABLE 13

LEAST SQUARES MEANS AND STANDARD DEVIATIONS FOR CARCASS CHARACTERISTICS OF TRIAL 1 GROUP FED CALVES

	Breed of dam and supplement level							
	Hereford		Hereford x Holstein		Holstein			
Item	Moderate	High	Moderate	High	Moderate	High	Very High	SD
No. of head	13	11	8	11	3	8	8	
Hot carcass wt., kg	280^{a}	282^{a}	299^{a}	293^{a}	338^{b}	346^{b}	334^{b}	25.14
Carcass weight/day of age, kg	$.66^{a}$	$.66^{a}$	$.67^{a}$	$.66^{a}$	$.78^{b}$	$.73^{b}$	$.69^{ab}$	.07
Rib eye area, cm	80.5^{a}	78.9^{a}	82.1^{a}	82.9^{a}	98.9^{b}	87.9^{ab}	84.2^{a}	9.94
REA/100 kg carcass, cm	28.8^{b}	27.9^{b}	27.5^{ab}	28.4^{b}	29.3^{b}	25.3^{a}	25.1^{a}	2.55
Fat thickness[d], cm	1.67^{ab}	1.61^{ab}	1.74^{b}	1.61^{ab}	1.29^{a}	1.26^{a}	1.50^{a}	.41
Fat thickness/100 kg[d] carcass, cm	$.59^{c}$	$.57^{bc}$	$.59^{c}$	$.55^{bc}$	$.38^{a}$	$.38^{a}$	$.45^{ab}$	.15
K, H, P Fat[e], %	3.2^{a}	3.3^{a}	3.4^{a}	3.3^{a}	2.7^{a}	3.1^{a}	3.2^{a}	.63
K, H, P Fat/100 kg[e] carcass, %	1.14^{bc}	1.17^{c}	1.14^{bc}	1.13^{bc}	$.80^{a}$	$.90^{a}$	$.96^{ab}$	.22
Cutability, %	49.3^{a}	49.2^{a}	48.9^{a}	49.4^{a}	51.6^{b}	50.0^{ab}	49.2^{a}	1.61
Conformation score[f]	11.2^{a}	11.2^{a}	11.3^{a}	10.6^{a}	11.7^{a}	10.2^{a}	10.3^{a}	1.08
Marbling score[g]	13.7^{a}	14.3^{ab}	15.0^{ab}	15.5^{ab}	15.1^{ab}	15.8^{b}	15.0^{ab}	2.26
Carcass grade[f]	9.8^{a}	10.0^{a}	10.2^{a}	10.2^{a}	10.7^{a}	10.4^{a}	9.9^{a}	.97
Warner-Bratzler shear value[h], kg	8.7^{a}	9.4^{a}	9.1^{a}	9.5^{a}	8.3^{a}	9.1^{a}	9.9^{a}	1.88
Cooking loss[i], %	31.4^{ab}	34.2^{b}	26.6^{a}	34.1^{b}	24.8^{a}	33.1^{b}	34.8^{b}	6.28
Ether extract[j], %	4.3^{a}	4.6^{a}	4.6^{a}	5.4^{a}	4.7^{a}	5.3^{a}	5.5^{a}	1.25
Protein[j], %	21.8^{b}	21.6^{ab}	21.6^{ab}	21.1^{a}	21.4^{ab}	21.4^{ab}	21.5^{ab}	.70
Dry matter[j], %	27.5^{ab}	27.0^{a}	27.6^{ab}	28.0^{ab}	27.8^{ab}	28.1^{b}	28.2^{b}	1.07

[abc]Means on the same line with the same superscript letter are not significantly different (P .05).

[d]Average of three measurements taken 1/4, 1/2, 3/4 length of longissimus.

[e]Kidney, heart and pelvic fat.

[f]9=High Good 10=Low Choice 11=Average Choice.

[g]Based on 30 point scale, 12=Slight+, 13=Small-, 14=Small, 15=Small+, 16=Modest-, 17=Modest.

[h]Mean of three 2.54 centimeter cores sheared 3 times each.

[i]Loss during deep frying of 5.09 cm trimmed steak.

[j]Composition of three 2.54 cm cores from longissimus.

TABLE 14

LEAST SQUARES MEANS AND STANDARD DEVIATIONS FOR CARCASS CHARACTERISTICS OF TRIAL 1 INDIVIDUALLY FED CALVES

Item	Breed of dam and supplement level							SD
	Hereford		Hereford x Holstein		Holstein			
	Moderate	High	Moderate	High	Moderate	High	Very High	
No. of head	5	5	5	5	5	4	5	
Hot carcass wt., kg	268^{a}	294^{ab}	262^{a}	334^{b}	323^{b}	336^{b}	333^{b}	40.35
Carcass weight/day of age, kg	.63^{a}	.64^{a}	.63^{a}	.72^{a}	.66^{a}	.70^{a}	.68^{a}	.08
Rib eye area, cm	70.0^{a}	81.8^{ab}	73.7^{a}	90.5^{b}	76.5^{ab}	71.8^{a}	81.9^{ab}	10.57
REA/100 kg carcass, cm	26.1^{bc}	27.8^{c}	28.1^{c}	27.1^{bc}	23.7^{ab}	21.4^{a}	24.6^{abc}	3.01
Fat thickness^{d}, cm	1.6^{b}	1.8^{b}	1.4^{ab}	1.3^{ab}	1.0^{a}	1.4^{ab}	1.1^{a}	.34
Fat thickness/100 kg^{d} carcass, cm	.60^{c}	.61^{c}	.53^{bc}	.39^{ab}	.31^{a}	.42^{ab}	.33^{a}	.11
K, H, P Fat^{e}, %	3.8^{a}	3.4^{a}	3.9^{a}	3.8^{a}	3.8^{a}	4.2^{a}	4.2^{a}	.73
K, H, P Fat/100 kg^{e} carcass, %	1.42^{a}	1.16^{a}	1.49^{a}	1.14^{a}	1.19^{a}	1.25^{a}	1.26^{a}	.26
Cutability, %	48.1^{ab}	48.9^{ab}	48.8^{ab}	49.6^{b}	49.1^{ab}	47.2^{a}	48.9^{ab}	1.70
Conformation score^{f}	9.4^{ab}	10.7^{ab}	10.7^{ab}	11.2^{b}	9.4^{ab}	8.8^{a}	10.6^{ab}	1.61
Marbling score^{g}	12.6^{a}	14.6^{abc}	12.6^{a}	13.2^{ab}	14.6^{abc}	16.3^{bc}	16.8^{c}	2.60
Carcass grade^{f}	9.4^{a}	10.2^{ab}	9.4^{a}	9.8^{ab}	9.6^{ab}	10.8^{b}	10.4^{ab}	.91
Warner-Bratzler shear value^{h}, kg	9.8^{b}	8.3^{b}	8.1^{ab}	10.0^{b}	7.7^{ab}	6.0^{a}	8.7^{b}	1.61
Cooking loss^{i}, %	31.9^{ab}	33.4^{b}	32.6^{ab}	31.6^{ab}	33.6^{b}	24.9^{a}	32.0^{ab}	5.99
Ether extract^{j}, %	4.7^{a}	4.9^{ab}	4.7^{a}	4.4^{a}	5.5^{ab}	6.3^{b}	5.6^{ab}	1.07
Protein^{j}, %	22.0^{a}	22.3^{a}	21.1^{a}	21.4^{a}	21.2^{a}	21.2^{a}	21.8^{a}	.90
Dry matter^{j}, %	28.0^{a}	28.9^{a}	27.6^{a}	27.8^{a}	28.4^{a}	28.5^{a}	28.3^{a}	.97

[abc]Means on the same line with the same superscript letter are not significantly different (P .05).

[d]Average of three measurements taken 1/4, 1/2, 3/4 length of longissimus.

[e]Kidney, heart and pelvic fat.

[f]9=High Good 10=Low Choice 11=Average Choice.

[g]Based on 30 point scale, 12=Slight+, 13=Small-, 14=Small, 15=Small+, 16=Modest-, 17=Modest.

[h]Mean of three 2.54 centimeter cores sheared 3 times each.

[i]Loss during deep frying of 5.09 cm trimmed steak.

[j]Composition of three 2.54 cm cores from longissimus.

no apparent logical basis; any real supplement level of dam effect would probably have been reflected in progeny of high supplement level dams having more KHP fat and a better conformation score due to more external fat. Even this trend was not expected, however, since supplement level of dam affected neither milk yield nor weaning weight.

In trial 2 individually fed calves quality grade was significantly ($P<.02$) higher for progeny of dams fed the high level of winter supplement. Treatment of dam had no effect ($P>.05$) on any carcass traits in trial 1 individually fed calves (table 12) or trial 2 group fed calves (table 13).

Since so few traits of the large number observed (17 traits in each of four trials) were significantly ($P<.05$) influenced by supplement level of dam, significant differences were probably random occurrences; it was concluded that supplement level of dam had little influence on carcass characteristics of progeny. This is not surprising since supplement level of dams had little affect on milk yield or weight of progeny at weaning (Dean et al., 1973).

Breed of Dam

Means for progeny by breed of dam are presented in tables 15 and 16 for group and individually fed calves sired by Angus bulls and in tables 17 and 18 for group and individually fed calves sired by Charolais bulls, respectively. These means are the weighted averages of sex adjusted means presented in tables 11 through 14. Standard deviations, the same as those shown in tables 11 through 14, were obtained from analysis of variance conducted on the seven breed-supplement level combinations in a one way classification with the

TABLE 15

BREED MEANS AND STANDARD DEVIATIONS FOR CARCASS CHARACTERISTICS OF TRIAL 1 GROUP FED CALVES

Item	Breed of dam			SD
	Hereford	Hereford x Holstein	Holstein	
No. of head	25	26	34	
Hot carcass weight, kg	241^{a}	272^{b}	309^{c}	23.77
Carcass weight/day of age, kg	.64^{a}	.69^{b}	.72^{c}	.05
Rib eye area, cm	69.8^{a}	73.9^{b}	77.8^{c}	6.84
REA/100 kg carcass, cm	29.0^{c}	27.0^{b}	25.4^{a}	2.42
Fat thickness[d], cm	2.1^{a}	2.4^{b}	2.1^{a}	.41
Fat thickness/100 kg carcass, cm	.89^{b}	.88^{b}	.68^{a}	.11
K, H, P Fat[e], %	3.1^{a}	3.4^{b}	3.5^{b}	.39
K, H, P Fat/100 kg[e] carcass, %	1.31^{b}	1.25^{b}	1.13^{a}	.15
Cutability, %	48.0^{a}	47.2^{a}	47.5^{a}	1.43
Conformation score[f]	11.2^{a}	11.0^{a}	10.1^{b}	.82
Marbling score[g]	13.4^{a}	13.8^{a}	16.4^{b}	2.91
Carcass grade[f]	9.5^{a}	9.6^{a}	10.5^{b}	1.13
Warner-Bratzler shear value[h], kg	7.9^{a}	8.0^{a}	7.6^{a}	1.56
Cooking loss[i], %	31.9^{a}	31.6^{a}	30.7^{a}	3.44
Ether extract[j], %	5.0^{ab}	4.7^{a}	5.7^{b}	1.40
Protein[j], %	20.9^{a}	20.7^{a}	21.0^{a}	.79
Dry matter[j], %	27.9^{a}	27.6^{a}	28.7^{b}	1.48

[abc]Means on the same line with the same superscript letter are not significantly different ($P > .05$).

[d]Average of three measurements taken 1/4, 1/2, 3/4 length of longissimus.

[e]Kidney, heart and pelvic fat.

[f]9=High Good 10=Low Choice 11=Average Choice.

[g]Based on 30 point scale, 12=Slight+, 13=Small-, 14=Small, 15=Small+, 16=Modest-, 17=Modest.

[h]Mean of three 2.54 centimeter cores sheared 3 times each.

[i]Loss during deep frying of 5.09 cm trimmed steak.

[j]Composition of three 2.54 cm cores from longissimus.

TABLE 16

BREED MEANS AND STANDARD DEVIATIONS FOR CARCASS CHARACTERISTICS OF TRIAL 1 INDIVIDUALLY FED CALVES

Item	Breed of dam			SD
	Hereford	Hereford x Holstein	Holstein	
No. of head	9	9	14	
Hot carcass weight, kg	241[a]	281[b]	307[c]	27.13
Carcass weight/day of age, kg	.56[a]	.61[b]	.63[b]	.05
Rib eye area, cm	77.6[a]	78.1[a]	75.3[a]	8.90
REA/100 kg carcass, cm	32.3[c]	27.7[b]	24.6[a]	2.71
Fat thickness[d], cm	1.8[a]	1.5[a]	1.6[a]	.38
Fat thickness/100 kg carcass, cm	.74[b]	.56[a]	.54[a]	.15
K, H, P Fat[e], %	2.9[a]	3.3[a]	3.1[a]	.67
K, H, P Fat/100 kg[e] carcass, %	1.22[b]	1.20[b]	1.02[a]	.26
Cutability, %	49.9[a]	49.3[a]	48.5[a]	1.83
Conformation score[f]	10.8[b]	8.7[a]	9.3[ab]	1.83
Marbling score[g]	12.0[a]	13.3[a]	13.4[a]	3.26
Carcass grade[f]	9.4[a]	9.6[a]	9.2[a]	1.40
Warner-Bratzler shear value[h], kg	7.9[a]	7.6[a]	7.5[a]	1.70
Cooking loss[i], %	33.0[a]	34.7[a]	33.1[a]	4.88
Ether extract[j], %	3.7[a]	4.4[a]	5.1[a]	1.86
Protein[j], %	21.4[b]	21.5[b]	20.7[a]	.42
Dry matter[j], %	26.9[a]	28.1[ab]	28.6[a]	1.59

[abc]Means on the same line with the same superscript letter are not significantly different (P>.05).

[d]Average of three measurements taken 1/4, 1/2, 3/4 length of longissimus.

[e]Kidney, heart and pelvic fat.

[f]9=High Good 10=Low Choice 11=Average Choice.

[g]Based on 30 point scale, 12=Slight+, 13=Small-, 14=Small, 15=Small+, 16=Modest-, 17=Modest.

[h]Mean of three 2.54 centimeter cores sheared 3 times each.

[i]Loss during deep frying of 5.09 cm trimmed steak.

[j]Composition of three 2.54 cm cores from longissimus.

TABLE 17

BREED MEANS AND STANDARD DEVIATIONS FOR CARCASS CHARACTERISTICS OF TRIAL 1 GROUP FED CALVES

	Breed of dam			
Item	Hereford	Hereford x Holstein	Holstein	SD
No. of head	24	19	19	
Hot carcass weight, kg	281[a]	296[a]	340[b]	25.14
Carcass weight/day of age, kg	.66[a]	.67[a]	.73[b]	.07
Rib eye area, cm	79.8[a]	82.5[ab]	88.1[b]	9.94
REA/100 kg carcass, cm	28.4[b]	27.9[b]	25.4[a]	2.55
Fat thickness[d], cm	1.6[b]	1.7[b]	1.4[a]	.41
Fat thickness/100 kg carcass, cm	.59[b]	.57[b]	.40[a]	.15
K, H, P Fat[e], %	3.3[a]	3.3[a]	3.1[a]	.63
K, H, P Fat/100 kg[e] carcass, %	1.17[b]	1.12[b]	.90[a]	.22
Cutability, %	49.3[a]	49.2[a]	49.9[a]	1.61
Conformation score[f]	11.2[b]	10.9[ab]	10.5[a]	1.08
Marbling score[g]	13.9[a]	15.3[b]	15.4[b]	2.26
Carcass grade[f]	9.9[a]	10.2[a]	10.2[a]	.97
Warner-Bratzler shear value[h], kg	9.0[a]	9.4[a]	9.3[a]	1.88
Cooking loss[i], %	32.7[a]	31.0[a]	32.2[a]	6.28
Ether extract[j], %	4.4[a]	5.1[ab]	5.3[b]	1.25
Protein[j], %	21.7[a]	21.3[a]	21.4[a]	1.25
Dry matter[j], %	27.3[a]	27.8[ab]	28.1[b]	1.07

[abc] Means on the same line with the same superscript letter are not significantly different (P>.05).

[d] Average of three measurements taken 1/4, 1/2, 3/4 length of longissimus.

[e] Kidney, heart and pelvic fat.

[f] 9=High Good 10=Low Choice 11=Average Choice.

[g] Based on 30 point scale, 12=Slight+, 13=Small-, 14=Small, 15=Small+, 16=Modest-, 17=Modest.

[h] Mean of three 2.54 centimeter cores sheared 3 times each.

[i] Loss during deep frying of 5.09 cm trimmed steak.

[j] Composition of three 2.54 cm cores from longissimus.

TABLE 18

BREED MEANS AND STANDARD DEVIATIONS FOR CARCASS CHARACTERISTICS OF TRIAL 1 INDIVIDUALLY FED CALVES

	Breed of dam			
		Hereford x		
Item	Hereford	Holstein	Holstein	SD
No. of head	10	10	14	
Hot carcass weight, kg	281[a]	298[ab]	330[b]	40.35
Carcass weight/day of age, kg	.63[a]	.67[a]	.68[a]	.08
Rib eye area, cm	75.9[a]	82.1[a]	77.1[a]	10.57
REA/100 kg carcass, cm	27.1[b]	27.7[b]	23.5[a]	3.01
Fat thickness[d], cm	1.7[b]	1.4[b]	1.1[a]	.34
Fat thickness/100 kg[d] carcass, cm	.60[c]	.46[b]	.34[a]	.11
K, H, P Fat , %	3.6[a]	3.9[a]	4.1[a]	.73
K, H, P Fat/100 kg[e] carcass, %	1.31[a]	1.32[a]	1.25[a]	.26
Cutability, %	48.5[a]	49.2[a]	48.5[a]	1.70
Conformation score[f]	10.0[a]	11.0[a]	9.6[a]	1.61
Marbling score[g]	13.6[a]	12.9[a]	15.9[b]	2.60
Carcass grade[f]	9.8[a]	9.6[a]	10.2[a]	.91
Warner-Bratzler shear value[h], kg	9.0[b]	9.1[b]	7.6[a]	1.61
Cooking loss[i], %	32.6[a]	32.1[a]	30.5[a]	5.99
Ether extract[j], %	4.8[a]	4.5[a]	5.8[b]	1.07
Protein[j], %	22.1[b]	21.3[a]	21.6[ab]	.90
Dry matter[j], %	28.4[b]	27.7[a]	28.4[b]	.97

[abc]Means on the same line with the same superscript letter are not significantly different (P>.05).

[d]Average of three measurements taken 1/4, 1/2, 3/4 length of longissimus.

[e]Kidney, heart and pelvic fat.

[f]9=High Good 10=Low Choice 11=Average Choice.

[g]Based on 30 point scale, 12=Slight+, 13=Small-, 14=Small, 15=Small+, 16=Modest-, 17=Modest.

[h]Mean of three 2.54 centimeter cores sheared 3 times each.

[i]Loss during deep frying of 5.09 cm trimmed steak.

[j]Composition of three 2.54 cm cores from longissimus.

breed-supplement level combination being the classification factor.

Hot Carcass Weight and Carcass Weight/Day of Age. Carcass weight increased with each increment of Holstein breeding. Carcasses of Holstein progeny were significantly ($P<.05$) heavier (68, 66, 59 and 49 kg) than carcasses of Hereford progeny in all four comparisons. Carcasses of Crossbred progeny were significantly ($P<.05$) heavier than carcasses of Hereford progeny in two comparisons and lighter than carcasses of Holstein progeny in three comparisons. These breed differences are a reflection of increases in weaning weight and length of feeding period; in spite of decreases in daily feedlot gain, with increasing increments of Holstein breeding (Dean *et al.*, 1973).

Holstein progeny had a heavier ($P<.05$) carcass weight per day of age than Hereford progeny in three of four comparisons. Crossbred progeny excelled ($P<.05$) Hereford progeny in two comparisons and was inferior ($P<.05$) to Holstein progeny in one comparison. Breed differences in carcass weight per day of age were smaller and statistically significant less frequently than differences in total carcass weight because of lower daily feedlot gain and greater slaughter age with each increasing increment of Holstein breeding.

Rib Eye Area and Rib Eye Area/100 kg Carcass. Holstein progeny had greater rib eye area than Hereford progeny in only two of four comparisons. In only one comparison was there a progressive increase ($P<.05$) with each increasing increment of Holstein breeding, in spite of increases in carcass weight with increasing Holstein breeding. These results are consistent with comparisons between straight-bred Angus or Herefords and Holsteins; at slaughter weights less than 450 kg, the British beef breeds had an advantage over Holsteins (Cole *et* al., 1963; Judge et al., 1965; Minish et al., 1966; Wellington, 1971), while at heavier carcass weights beef vs. dairy breed differences were not apparent (Hanke et al., 1964; Burroughs et al., 1965; Minish et al., 1965).

Both Hereford and Crossbred progeny had greater ($P<.05$) rib eye area/100 kg carcass than Holstein progeny in every comparison; Hereford and Crossbred progeny were different ($P<.05$) in only one comparison. It appears that increasing increments of Holstein breeding, particularly as much as 50%, result in decreased muscling. Judge et al. (1965) also noted that Angus steers had more rib eye per kilogram of carcass weight than Holstein steers.

Fat Thickness and Fat Thickness/100 kg Carcass. Determination of slaughter time was based primarily on estimated carcass fatness. Therefore, breed of dam differences in carcass fatness were primarily a reflection of the imperfect subjective method which was used to determine slaughter time. Breed of dam differences in fat thickness were not large. Hereford and Crossbred progeny tended to be similar, but fatter ($P<.05$) than Holstein progeny in two of four comparisons. British beef breeds have been reported to be fatter than Holsteins (Cole et al., 1964; Hanke et al., 1964; Burroughs et al., 1965; Judge et al., 1965; Minish et al., 1966; Wellington, 1971) and Brown Swiss X Hereford crossbreds (Patterson et al., 1972). However, in previous work cattle were fed on a weight on time constant basis, whereas in this research the intended end point was comparable finish.

When fatness was expressed on a carcass weight basis, fatness decreased as Holstein breeding increased. This was due to the increase in carcass weight with increasing increments of Holstein breeding. Crossbred progeny was thinner ($P<.05$) than Hereford progeny in two comparisons and fatter ($P<.05$) than Holstein progeny in three comparisons; Hereford progeny was thinner than Holstein progeny in every comparison.

K, H, P Fat and K, H, P Fat/100 kg Carcass. Differences in KHP fat were generally nonsignificant ($P>.05$), in agreement with beef vs. Holstein comparisons previously reported (Cole et al., 1964; Larson et al., 1966; Minish et al., 1966). However, Holstein progeny had less KHP fat per 100 kg carcass than Hereford and Crossbred progeny, consistent with their tendancy to have less outside fat per 100 kg carcass.

Cutability. Increasing level of Holstein breeding had no affect on carcass cutability ($P>.05$). In contrast, previous reports have shown a higher cutability for Holsteins (Hanke et al., 1964; Burroughs et al., 1965; Larson et al., 1966; Minish et al., 1966) or part dairy steers (Ziegler et al., 1971; Patterson et al., 1972) than for Angus or Herefords. Differences in cutability were probably observed by these workers because cattle were fed equal time or to equal weight. On this basis, the later maturing dairy or part dairy cattle would be expected to have a higher cutability due to less fatness.

Conformation, Marbling and Carcass Grade. Conformation score tended to be lowered with Holstein breeding. Crossbred progeny had a lower conformation score than Hereford progeny in three of four comparisons; the difference was significant ($P<.05$) in one comparison. Holstein progeny had a lower conformation score than Hereford progeny in every comparison; the difference was significant in two comparisons. These observations relative to conformation are consistent with the decreased muscling (rib eye area/100 kg carcass) of Holstein progeny as well as previous reports indicating a lower conformation score for straightbred Holsteins than for beef breeds (Minish et al., 1965; Larson et al., 1966).

Marbling tended to increase with Holstein breeding. Crossbred progeny had more marbling than Hereford progeny in three comparisons; the difference was significant ($P<.05$) in one comparison. Holstein progeny had the highest marbling score in every comparison, significantly ($P<.05$) higher than Crossbred and Hereford progeny in two and three comparisons, respectively. Similarly, Larson et al (1966) noted that straightbred Holsteins had more marbling than straightbred Herefords, and Ziegler et al. (1971) reported that steers with 25% Holstein breeding were comparable to Herefords in marbling.

The design of this experiment involved slaughtering all animals as each reached an anticipated carcass grade of low choice. The fact that this was accomplished to a respectable degree is illustrated by means for USDA quality grade which show that all calves were slaughtered within one-third of a grade, high good to low choice. This was true across breed of dam, year and breed of sire and method of feeding. Differences in carcass grade were significant ($P<.05$) in only one comparison; Holstein progeny had a higher carcass grade than both Hereford and Crossbred progeny. Ziegler et al. (1971) also noted that 25% Holstein breeding did not decrease carcass grade. However, 50% Brown Swiss breeding (Patterson et al., 1972) or 100% Holstein Breeding (Branaman et al., 1966; Cole et al., 1964; Minish et al., 1966; Garrett, 1969) decreased carcass grade below that of beef steers when cattle were fed to similar weights or equal time.

Warner-Bratzler Shear Value and Cooking Loss. Although Holstein progeny had a significantly ($P<.05$) lower shear value than Hereford and Crossbred progeny in one comparison, an obvious breed of dam effect was not apparent. This agrees with previous work comparing beef breeds to 25% (Ziegler et al., 1971) or 100% (Branaman et al., 1962; Cole et al., 1964) Holstein breeding.

Differences in cooking loss of the rib steak were not significant ($P>.05$) in any comparison, and no trends were apparent.

Ether Extract, Protein and Dry Matter of Longissimus. Holstein progeny had the highest percentage of ether extract in every comparison, significantly ($P<.05$) more than Hereford and Crossbred progeny in two comparisons in each case. This is consistent with the greater marbling of Holstein progeny. Differences in percent protein were small, and no breed of dam effect was apparent. Holstein progeny had the highest percent dry matter in every comparison, significantly ($P<.05$) more than Crossbreds and Herefords in two and three comparisons, respectively. The higher dry matter of the Holstein progeny can be attributed to their higher ether extract values.

Discussion

Hereford progeny excelled in muscling (rib eye area/100 kg carcass) and conformation score, while Holstein progeny had heavier carcasses (total and per day of age), less fat and more marbling; Crossbred progeny was intermediate. Cutability was not affected by breed of dam. These results indicate that calves with 25 or 50% Holstein breeding yield carcasses comparable in total merit to beef calves if fed to comparable grade. In previous research involving comparisons between beef breeds and part or straightbred Holsteins, cattle have been fed equal time or to equal weight; under these circumstances the growthier, later maturing Holstein or part-Holstein cattle have been at a disadvantage in terms of grade. These results suggest that the normal market discount for part Holstein calves may not be justified.

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