CARCASS TRAITS AND LONGISSIMUS SHEAR VALUES OF OPEN HEIFERS AND 30-MONTH-OLD HEIFERS THAT PRODUCED ONE CALF

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INTRODUCTION

Feeding steers for slaughter has long been the main supply of beef for purveyor and retail beef sales. However, during the last 40 years, heifers in the U.S. slaughter mix have nearly doubled. This change has resulted in a more efficient beef production system.

John Brethour of the Fort Hays branch of the Kansas Agricultural Experiment Station (personal communication) developed the Single-Calf-Heifer System (SCHS), which involves retaining surplus heifers, breeding them to produce one calf, and finishing the heifers in a feedlot beginning shortly after parturition. The SCHS is very efficient because it combines reproduction and meat production into one system.

The current USDA grading system sorts carcasses into groups based on quality- and yield-indicating traits. Maturity is an important quality-indicating trait, in which "A" and "B" maturity carcasses are from cattle up to 30 mo. and 42 mo. of age, respectively. When cattle have bone and/or lean characteristics typical of cattle older than 42 mo., they are classified as C, D, or E maturity, or "hard boned." "Hard-boned" carcasses are not eligible for the same grades as A and B maturity carcasses.

Preliminary performance results indicate that when the traditional, cow-calf system was replaced with the SCHS, estimated returns increased about 3.8 times. Also, carcasses produced from the SCHS have received USDA quality and yield grades similar to those of heifers of similar ages that have not had a calf (John Brethour, personal communication). In study 1 of a report published by Bond et al. 1986, heifers that calved had lower dressing percentages ($P < .01$), less fat over the *longissimus* muscle ($P < .01$), smaller *longissimus* muscle areas ($P < .01$) and lower USDA yield grades ($P < .05$) than open heifers. There were no differences in lean color, texture, and firmness; maturity traits; or marbling between the open and pregnant heifers. However, little is known about the effects of pregnancy, parturition, and lactation on physiological maturity, all of which could have a detrimental effect on meat tenderness and other palatability traits. Therefore, the objective of our research was to evaluate the effects of calving on carcass yield and quality traits, and tenderness of the *longissimus* muscle from cattle produced by the SCHS.

EXPERIMENTAL METHODS

Eighty-seven, 3/8 Simmental x 5/8 Hereford heifers (born in 1985) were bred to Red Angus and White Park sires at 14 to 16 mo. of age. Eighty-seven heifers that calved at about 2 years of age were designated as Single-Calf-Heifers, and either implanted with Synovex-H or nonimplanted (I-SCH and NI-SCH, respectively). Twenty-six, 2-year-old, open-heifer (2-OH) mates served as controls. Additionally, 22, 1-year-old, open-heifers (1-OH) born in 1986 from the same source also were utilized as controls. The 1-OH

TABLE 1. LEAST SQUARES MEANS FOR PERFORMANCE CHARACTERISTICS OF 1-YEAR-OLD-OPEN-HEIFERS, 2-YEAR-OLD-OPEN-HEIFERS, AND IMPLANTED AND NONIMPLANTED SINGLE-CALF-HEIFERS.

	Treatments[a]			
Characteristics	1-OH	2-OH	I-SCH	NI-SCH
Number of heifers	22	26	33	54
Days in feedlot	137	112	137	137
Feedlot average-daily-gain, kg/d	1.1[b]	1.3[c]	1.0[b]	1.0[b]
Hot carcass weight, kg	296[b]	338[c]	326[c]	319[bc]
Dressing percent	63.7[b]	63.0[b]	62.7[b]	60.7[c]

[a] Treatments: 1-OH = 1-year-old-open-heifers; 2-OH = 2-year-old-open-heifers; I-SCH = implanted, single-calf-heifers; NI-SCH = nonimplanted, single-calf-heifers.

[b,c] Means within a row without a common superscript letter differ ($P<.05$).

TABLE 2. LEAST SQUARES MEANS FOR QUALITY CHARACTERISTICS OF 1-YEAR-OLD-OPEN-HEIFERS, 2-YEAR-OLD-OPEN-HEIFERS, AND IMPLANTED AND NONIMPLANTED SINGLE-CALF-HEIFERS.

	Treatments[a]			
Characteristics	1-OH	2-OH	I-SCH	NI-SCH
Lean color[b]	2.0[g]	2.6[h]	2.6[h]	2.5[h]
Lean firmness[c]	2.6	2.8	2.5	2.6
Heat-ring incidence[d]	1.5	1.3	1.4	1.5
USDA marbling score[e]	321	303	301	314
USDA quality grade[f]	300	286	288	289

[a] Treatments: 1-OH = 1-year-old-open-heifers; 2-OH = 2-year-old-open-heifers; I-SCH = implanted, single-calf-heifers; NI-SCH = nonimplanted, single-calf-heifers.

[b] Color of lean: 1 = very light cherry red, 2 = cherry red, 3 = slightly dark red, ..., 7 = black.

[c] Firmness of lean: 1 = very firm, 2 = firm, 3 = moderately firm, ..., 7 = extremely soft.

[d] Presence of heat ring (dark coarse band): 1 = none, ..., 5 = extremely severe.

[e] USDA marbling score: 200-299 = slight, 300-399 = small.

[f] USDA quality grade: 200-299 = Select, 300-399 = low Choice.

[g,h] Means within a row without a common superscript letter differ ($P<.05$).

and 2-OH groups were fed a high-grain diet for 137 and 112 d, respectively, before being slaughtered. Heifers that calved were started on the high-grain diet about 1 mo. after calving and were fed for 137 d before slaughter. The SCH assigned to the implanted treatment group were implanted when started on the high-grain diet. Calves were early weaned about 5 wk. prior to slaughter. All treatment groups were fed and slaughtered at approximately the same time.

After slaughter, carcasses were chilled at 1°C for about 22 hr. and evaluated for USDA (1976) yield and quality grades by a qualified, three-member panel. Skeletal and lean maturity scores were recorded as A maturity (0-99), B maturity (100-199) and C maturity (200-299). Additionally, lean color, firmness, and incidence of "heat ring" (dark, coarse band in the *longissimus* muscle) were evaluated.

Fifteen ribs were randomly selected from each treatment group and vacuum aged for 7 d at 1°C. Steaks (2.54 cm thick) were cut from each rib and modified oven-broiled (AMSA, 1978) at 165°C to an internal temperature of 70°C. Steaks were cooled at room temperature for 2 hr. before eight, 1.27 diameter cores were taken and sheared through the center using the Warner-Bratzler shear device mounted to an Instron Universal Testing Machine (model 4201). Thawed and cooked weights were taken to calculate cooking losses.

Data were analyzed using analysis of variance procedures of the Statistical Analysis System (1982). Differences in main effects (age, calving, and implanting) and interactions are discussed.

TABLE 3. LEAST SQUARES MEANS FOR YIELD CHARACTERISTICS OF 1-YEAR-OLD-OPEN-HEIFERS, 2-YEAR-OLD-OPEN-HEIFERS, AND IMPLANTED AND NONIMPLANTED SINGLE-CALF-HEIFERS.

Characteristics	Treatments[a]			
	1-OH	2-OH	I-SCH	NI-SCH
Fat thickness, cm	.71	.81	.91	.91
Adjusted fat thickness, cm	.91	.91	.91	1.12
Kidney, pelvic and heart fat, %	2.9[c]	1.8[d]	1.7[d]	2.1[d]
Longissimus area, cm^2	91.0	92.9	92.3	91.0
USDA yield grade[b]	2.0	2.0	2.0	2.2

[a]Treatments: 1-OH = 1-year-old-open-heifers; 2-OH = 2-year-old-open-heifers; I-SCH = implanted, single-calf-heifers; NI-SCH = nonimplanted, single-calf-heifers.

[b]USDA yield grade: 1 = highest percentage and 5 = lowest percentage of closely trimmed, mostly boneless meat cuts.

[c,d]Means within a row without a common superscript letter differ (P<.05).

TABLE 4. LEAST SQUARES MEANS FOR MATURITY CHARACTERISTICS OF 1-YEAR-OLD-OPEN-HEIFERS, 2-YEAR-OLD-OPEN-HEIFERS, AND IMPLANTED AND NONIMPLANTED SINGLE-CALF-HEIFERS.

Characteristics	Treatments[a]			
	1-OH	2-OH	I-SCH	NI-SCH
USDA bone maturity:				
Sacral[b]	75[c]	89[cd]	108[e]	100[de]
Lumbar[b]	69[c]	83[cd]	101[e]	94[de]
Thoracic[b]	64[c]	88[cd]	114[e]	99[de]
Feather bone[b]	80[c]	101[d]	106[d]	114[d]
Rib bone[b]	89[c]	100[cd]	114[d]	110[d]
Overall bone maturity[b]	74[c]	93[cd]	113[e]	105[de]
USDA lean maturity[b]	55[c]	81[d]	87[d]	79[d]
USDA carcass maturity[b]	70[c]	90[d]	106[e]	98[de]

[a]Treatments: 1-OH = 1-year-old-open-heifers; 2-OH = 2-year-old-open-heifers; I-SCH = implanted, single-calf-heifers; NI-SCH = nonimplanted, single-calf-heifers.

[b]Scores based on: 0-99 = A maturity, 100-199 = B maturity, 200-299 = C maturity ("hard boned").

[c,d,e]Means within a row without a common superscript letter differ (P<.05).

RESULTS AND DISCUSSION

Performance characteristics of the treatment groups are given in table 1. Feedlot average-daily-gains were highest ($P<0.05$) for 2-OH, and no differences ($P>0.05$) occurred among the other treatments. This contradicts results reported by Bond et al. (1986), but their feeding period was only 42 d. Apparently, the 2-OH were able to convert their energy intake above maintenance for gain, whereas I-SCH and NI-SCH had to use energy for both gain and milk production. The advantage in gain for 2-OH over 1-OH likely was due to their larger size and greater feed capacity. I-SCH and 2-OH had heavier ($P<0.05$) carcasses than 1-OH; NI-SCH were intermediate in carcass weights. The NI-SCH exhibited the lowest ($P<0.05$) dressing percentages (60.7%), and there were no differences among the other treatments (62.7 to 63.7%). This contradicts results of Roux et al. (1987) and Bond et al. (1986) and this could be due to differences in breed type and days on feed, respectively. We have no explanation for the low dressing percents for our NI-SCH.

As expected, 1-OH had the lightest ($P<0.05$) colored lean, and there were no lean color differences among the other treatment groups (table 2). These results agree with reports by Dumont et al. (1987) and Bond et al. (1986) (study 1) that pregnancy and calving had no effect on lean color. In addition, there were no differences ($P>0.05$) in lean firmness, incidence of heat ring, USDA marbling scores and quality grades among treatment groups in our study. Therefore, visual

TABLE 5. LEAST SQUARES MEANS FOR COOKING LOSSES AND WARNER-BRATZLER SHEAR VALUES OF LONGISSIMUS STEAKS FROM 1-YEAR-OLD-OPEN-HEIFERS, 2-YEAR-OLD-OPEN-HEIFERS, AND IMPLANTED AND NONIMPLANTED SINGLE-CALF HEIFERS.

Characteristics	Treatments[a]			
	1-OH	2-OH	I-SCH	NI-SCH
Number of heifers	15	15	15	15
Cooking losses, %	19.2	19.9	20.9	20.0
Shear force, kg[b]	3.1[c]	3.3[cd]	3.9[e]	3.5[de]

[a]Treatments: 1-OH = 1-year-old-open-heifers; 2-OH = 2-year-old-open-heifers; I-SCH = implanted, single-calf-heifers; NI-SCH = nonimplanted, single-calf-heifers.

[b]Warner-Bratzler shear force determinations made on 1.27 cm diameter cores.

[c,d,e]Means within a row without a common superscript letter differ (P<.05).

quality traits of the *longissimus* muscle from heifers that calved were equal to those of 2-year-old heifers that did not calve. Our results agree with those from study 1 of Bond et al. (1986); however, our results for quality grades contradict those from study 2 of those authors. However, their longest feeding period was only 42 d, which likely was not adequate for calved heifers to deposit the same amount of marbling as those that did not calve.

Kidney, pelvic and heart fat percentages were highest ($P<0.05$) for 1-OH, and there were no differences among the other treatments (table 3). These results agree with those of Brookes and O'Byrne (1965). Additionally, there were no differences ($P>0.05$) in fat thicknesses, adjusted fat thicknesses, *longissimus* muscle areas or USDA yield grades among treatment groups. These results contradict results reported by Bond et al. (1986) (study 1). Data from tables 1, 2 and 3 show that carcass weights and USDA quality and yield grades were very desirable for all 2-year-old heifers. Therefore, having a calf had no negative effects on these traits.

Heifers that calved had higher ($P<0.05$) maturity scores than 1-OH for all eight maturity characteristics (table 4). Also, I-SCH were more mature ($P<0.05$) than 2-OH in five (sacral, lumbar, thoracic, overall bone and overall maturity) of the eight maturity characteristics. Our results contradict results reported by Bond et al (1986) (study 1) that there were no differences between open heifers and calved heifers for bone maturity and overall USDA carcass maturity. However, our results agree with those reported by Bond et al (1986) (study 2) indicating a difference ($P<.05$) in bone maturity and overall USDA carcass maturity. In our study, I-SCH did not differ ($P<.05$) from NI-SCH in any of the eight maturity characteristics. However, it should be noted that two of the I-SCH and one of the NI-SCH were classified as "C" bone maturity ("hard boned") which decreased their carcass wholesale value because their carcass quality grades were different than those of A and B maturity carcasses.

These were no differences ($P<0.05$) in cooking losses among treatment groups (table 5). *longissimus* muscles from I-SCH displayed higher ($P<0.05$) shear values than those from 1-OH and 2-OH. Also, *longissimus* muscles from NI-SCH had higher ($P<0.05$) shear values than those from 1-OH. Therefore, the combined effects of implanting and having a calf had a detrimental effect on *longissimus* muscle tenderness as measured by the Warner-Bratzler shear device. Also, the combination of increased age and having a calf had a detrimental effect on shear value. However, animal age, having a calf or implanting, individually, had no effect on *longissimus* shear values.

SUMMARY AND CONCLUSIONS

The I-SCH produced carcasses that had older maturity scores and rib steaks that were less tender than those from 1-OH or 2-OH. However, I-SCH carcasses had very desirable USDA yield and quality traits. The NI-SCH were very similar to 2-OH for yield and quality traits, whereas 2-OH had higher ($P<0.05$) feedlot average daily gains and dressing percentages than NI-SCH. The 1-OH had the highest ($P<0.05$) percentages of kidney, pelvic and heart fat, but yield grades equal to those of the other treatments.

It is possible to produce carcasses with desirable weights and USDA quality and yield grades from heifers that have produced one calf, then are fed a high-grain diet and slaughtered by 30 mo. of age. However, the combination of implanting and calving did increase ($P<.05$) *longissimus* shear force values. Implanting heifers that calved may result in more "hard boned" carcasses, but the improvement in dressing percent from implanting should more than offset this disadvantage.

ACKNOWLEDGEMENT

Contribution No. 88-524-A, Department of Animal Sciences and Industry, Kansas Agriculture Experiment Station, Manhattan, KS 66506-USA.

REFERENCES

AMSA. (1978). American Meat Science Association and National Live Stock and Meat Board. Chicago, Il.

Bond, J., Berry, B.W., Cross, H.R., Dinius, D.A. and Oltjen, R.R. (1986). *Nutrition Reports International* **34**:621.

Brookes, A.J. and O'Byrne, M. (1965). *Journal Royal Agriculture Society, England* **126**:30.

Dumont, R., Teissier, J.H., Bonnemaire, J. and Roux, M. (1987). *Livestock Production Science* **16**:21.

Roux, M., Teissier, J.H., Bonnemaire, J. and Dumont, R. (1987). *Livestock Production Science* **16**:1.

SAS. (1982). SAS User's Guide: Basics. Statistical Analysis Inst., Inc., Cary, N.C.

USDA. (1976). Official United States Standards for Grades of Carcass Beef. USDA Agricultural Marketing Service., Washington, D.C.