Serial ultrasound measures of implanted and non-implanted feedlot steers to determine carcass endpoints

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Abstract

An Aloka SSD-500V real-time ultrasound unit, equipped with a 17.2cm carcass probe, was used to serially scan feedlot steers (n = 80; initial BW 271 ± 99kg) at 42-d intervals during a 378-d feeding period by a certified Ultrasound Guidelines Council (UGC) technician. This included 10 separate ultrasound scanning sessions following the initial weight and ultrasound data taken on day minus 7 (one week prior to initial start date). Steers were randomly assigned to implant treatment (REV) or not (CON) at day minus 7 with the implanted group being re-implanted on day 190. Cattle were weighed and scanned for 12th-rib fat thickness (FTU), 12th-rib *longissimus* muscle area (LMAU), percentage intramuscular fat (%FATU), and rump fat thickness (RFU) to determine the ability of ultrasound to predict carcass grading outcomes at harvest in implanted vs non-implanted steers. Eight steers were harvested each 42 days and evaluated 48h after harvest to determine final body weight (FBW), 12th-rib fat thickness (FTC), 12th-rib *longissimus* muscle area (LMAC), and marbling score (MARB). Data were analyzed to determine treatment (TRT) and days on feed (DOF) interactions using the GLIMMIX procedure. Least square (LS) means illustrated differences (P<0.05) between TRT for FBW, FTU, REAU, and %FATU. No differences (P = 0.088) between TRT for RFU were observed. Differences (P<0.05) between DOF were observed for FBW through all 10 weigh days. A difference (P<0.05) across DOF for days 42, 84, 126, 168, 210, 252, and 294 was noted for FTU. These data suggest growth promoting implants cause differences (increases) in weight and traditional ultrasound measures of carcass endpoints.

Keywords: Steers, Implant, Serial, Ultrasound, Carcass

Introduction

Ultrasound technology has been used as an accurate, not-invasive means of determining carcass attributes for many years (Houghton & Turlington, 1992). The technology has been used primarily in differentiating seedstock breeding animals for development of Expected Progeny Differences (EPD's). However, commercial feedlot cattle have been ultrasounded for final harvest endpoints with some accuracy (Brethour, 2000). Serial harvest research isn't really new to the literature as scientists have quantified tissue changes in beef cattle throughout the feedlot phase (Carstens et al., 1991; Burns et al., 2004). Previous research by Sissom et al. (2007) looked at interactions between implanted versus non-implanted cattle for body composition with various days on feed. Limited research is available using ultrasound to measure weaned calves through an extended feeding phase (greater than 300 days on feed). The application of ultrasound technology has been implied to be less accurate in animals as they grow closer to a final endpoint in the feeding phase. This implication needs further investigation as ultrasound technicians have gained more experience and better equipment over time.

The objectives of this research project were to: 1) determine the accuracy of ultrasound to predict 12th rib fat thickness, ribeye area and intramuscular fat throughout an extended feeding phase, 2) determine the impact of a growth promoting implant program on accuracy of ultrasound to predict these body composition endpoints and 3) to determine the optimum scandate (days on feed) to predict final harvest marketing attributes.

Methods and Materials

Eighty Charolais-Angus crossbred steers were placed in the feedlot immediately after weaning and were randomly assigned as a control animal or an implanted animal. The cattle were fed typical of steers found in the US feedlot industry. Eight steers were harvested every 42 days beginning on day zero through 378 days on feed. All cattle were ultrasounded using an Aloka 500V real-time ultrasound unit equipped with a 17.2cm carcass probe on day minus 7 and day 0 and then serially measured every 42 days throughout the feeding phase (0, 42, 84, 126, 168, 210, 252, 294, 336 and 378) by a Ultrasound Guidelines Council certified technician. All images captured at chute side, saved and sent to the National Centralized Ultrasound Processing lab in Ames, IA for processing.

The live animal and carcass measures collected were: 1) 12th rib external fat thickness (FTU, FTC), 2) 12th rib *longissimus dorsi* muscle (LMAU, LMAC), 3) 12th rib intramuscular fat (%FATU, MARB) and rump fat (RFU) located at the juncture of the *gluteus medius* and *biceps femoris* muscles between the *ischium* and *illium*. All ultrasound measures were collected the day before harvest and the carcass data was collected 48h after harvest.

Results and Discussion

Table 1. Descriptive statistics for traits.

Trait[a]	Mean	SD	Min	Max
LWT (kg)	582.3	179.2	239	933
RFU (cm)	1.06	0.48	0.13	2.16
FTU (cm)	1.18	0.7	0.13	3.07
%FatU (%)	3.92	1.62	1.37	8.81
LMAU (cm^2)	89.5	20.4	43.8	129.7
HCW (kg)	369.6	123.6	133.2	603.5
FTC (cm)	1.22	0.79	0	3.25
MARB[b]	4.01	1.12	2.1	3.8
LMAC (cm^2)	85.4	16.9	50.3	119.4

[a]LWT = live weight; RFU = ultrasound rump fat; FTU = ultrasound 12th rib fat thickness; %FatU = ultrasound percent intramuscular fat; LMAU = ultrasound 12th rib *longissimus* dorsi area; HCW = hot carcass weight; FTC = carcass12th rib fat thickness; MARB = carcass marbling score; LMAC = carcass 12th rib *longissimus* dorsi area.
[b]MARB: 4.0 = Small 00; 5.0 = Modest 00; 6.0 = Moderate 00

Table 2. Simple correlations between ultrasound and carcass measures.

DOF[a]	LMA[a]	FT[a]	%Fat[a]
0	0.867^{*}	0.941^{*}	-0.473
42	0.880^{*}	0.908^{*}	0.6263
84	0.813^{+}	0.855^{+}	0.6892
126	0.849^{*}	0.898^{*}	-0.164
168	0.941^{*}	0.985^{*}	0.3746
210	0.907^{*}	0.916^{*}	0.6643
252	0.779^{+}	0.6218	0.803
294	0.1026	0.4922	0.4933
336	0.6846	0.974^{*}	-0.135
378	0.4362	0.762^{+}	0.5817
Overall	$\mathbf{0.931}^{*}$	$\mathbf{0.912}^{*}$	$\mathbf{0.755}^{*}$

[a]DOF = days on feed; LMA = 12 rib *longissimus* area; FT = 12th rib fat thickness; %Fat = intramuscular fat.
$^{*}P < .01$
$^{+}P < .05$

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Table 3. Least squares means of live and carcass measures for control (CON) vs implanted (REV).

	LMAU	LMAU		FTU	FTU		%FatU	%FatU		RFU	RFU	
SDOF	CON	TRT	SEM	CON	TRT	SEM	CON	TRT	SEM	CON	TRT	SEM
0	52.79^{l}	53.25^{l}	1.45	0.16^{j}	0.17^{j}	0.05	2.11^{i}	2.14^{i}	0.10	0.24^{j}	0.26^{j}	0.04
42	65.03^{k}	67.56^{k}	1.50	0.35^{i}	0.32^{i}	0.05	2.62^{h}	2.52^{h}	0.11	0.51^{i}	0.49^{i}	0.04
84	74.55^{j}	78.67^{i}	1.57	0.55^{h}	0.53^{h}	0.05	2.75^{gh}	2.78^{gh}	0.11	0.68^{h}	0.69^{h}	0.04
126	83.23^{h}	87.76^{g}	1.62	0.71^{g}	0.68^{g}	0.05	3.19^{f}	2.98^{fg}	0.11	0.78^{g}	0.80^{fg}	0.04
168	93.28^{f}	98.33^{de}	1.72	0.96^{f}	0.87^{f}	0.06	4.03^{d}	3.66^{e}	0.12	0.87^{f}	0.88^{f}	0.04
210	96.31^{ef}	101.62^{cd}	1.84	1.19^{de}	1.07^{e}	0.06	4.26^{d}	4.14^{d}	0.13	1.03^{e}	1.00^{e}	0.05
252	97.84^{e}	102.86^{c}	1.96	1.37^{bc}	1.25^{cd}	0.06	5.03^{ab}	4.79^{bc}	0.14	1.06^{de}	1.10^{de}	0.05
294	102.89^{bc}	104.83^{c}	2.09	1.43^{b}	1.40^{b}	0.07	5.11^{ab}	5.06^{ab}	0.14	1.13^{cd}	1.25^{b}	0.05
336	108.53^{ab}	112.62^{a}	2.50	1.77^{a}	1.47^{b}	0.08	4.75^{bc}	4.42^{cd}	0.17	1.22^{bc}	1.22^{bc}	0.07
378	107.86^{ab}	112.14^{a}	2.77	1.65^{a}	1.77^{a}	0.09	5.35^{a}	5.23^{ab}	0.20	1.24^{bc}	1.40^{a}	0.07

SDOF = ultrasound scan days on feed; RFU = ultrasound rump fat; FTU = ultrasound 12th rib fat thickness; %FatU = ultrasound percent intramuscular fat; LMAU = ultrasound 12th rib *longissimus* area.
Means with different superscripts by days of feed and within traits are significantly different (P < 0.05).

Results and Discussion

The cattle used in this study were fed longer than traditionally produced by feedlots in the US. This led to cattle having extremely heavy final weights at the end of the project with one weighing 933kg as shown in Table 1. This also resulted in heavy carcass weights on the kill floor with a heavy carcass of greater than 600kg. These large animals reduced the accuracy of the ultrasound technology across days on feed for all traits measured as indicated in Table 2.

Table 3 indicates an increase in ultrasound *longissimus* muscle area from day 0 through 168 days on feed. Ultrasound *longissimus* muscle area increased at a decreasing rate from 168 days on feed to 336 days on feed. 12th rib fat thickness and intramuscular fat increased from day 0 through day 378 days on as expected for both the control and treated groups. Day 336 was an exception to this increase and the researchers noted some extreme weather (excessive rainfall) changes leading up to this ultrasound date created some added stress to the cattle. An interesting component of the study was the relationship of 12th rib fat thickness deposition and rump fat thickness deposition over time. Rump fat depth appeared to slow the rate of deposition on or about day 168 days on feed but rib fat did not.

Least square means shown in Table 4 indicate treatment effects (control vs implanted) for 12th rib fat thickness, longissimus dorsi area and percent intramuscular fat.

Table 4. Least squares means for traits.

	CON	TRT	SEM	P-Value
LWT	540.3	560.3	21.25	0.0001
RFU	0.945^{a}	0.974^{a}	0.017	0.0879
FTU	1.079^{a}	1.014^{b}	0.022	0.0029
REAU	84.9^{a}	88.29^{b}	0.576	0.0001
%FatU	3.82^{a}	3.67^{b}	0.057	0.0142

[a]LWT = live weight; RFU = ultrasound rump fat; FTU = ultrasound 12th rib fat thickness; %FatU = ultrasound percent intramuscular fat; LMAU = ultrasound 12th rib *longissimus* dorsi area; CON = no implant; TRT = growth hormone implant.

Conclusions

These data suggests that ultrasound is an excellent method for determining final carcass attributes in feedlot cattle. The results indicate ultrasound measures taken on day 210 (or approximately 400 days of age) present the most precise and/or accurate carcass predictions. This is evident by the correlations of 0.907, 0.916 and 0.664 respectively for longissimus muscle area, 12th rib fat thickness and intramuscular fat. The high and significant overall correlations for longissimus muscle area (0.931) and 12th rib fat thickness (0.912) are exceptional. However, the lower correlation (0.755) for intramuscular fat suggests modifications may be needed to the algorithms used to estimate percent ether extractable fat by the certified UGC lab used to interpret the ether extractable fat data.