Relationship between Body Composition and Reproduction in Heifers

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Jennifer A. Minick, graduate student
Doyle E. Wilson, professor of animal science
Gene H. Rouse, professor of animal science
Abebe Hassen, assistant scientist
Mel Pence, adjunct instructor, veterinary medicine
R. Sealock, livestock research supervisor
Steven Hopkins, professor of veterinary medicine

Summary

Carcass and reproductive data including scan weight, ribeye area, rump fat, 12-13th rib fat and percentage intramuscular fat and reproductive tract scores (RTS) at 344 days were collected on 180 1998-born and 70 1999-born Angus heifers to determine the relationship between these traits. 1998-born heifers with higher RTS tended to be heavier and have more rump fat at 405 days (P < .05). Heavier heifers and heifers with more rump fat had higher RTS when adjusted to 395 days (P < .05). 1999-born heifers showed a similar pattern, with heavier heifers having higher RTS (P < .05). Rump fat was not as significant for 1999-born heifers compared with 1998-born heifers. Heavier heifers with more rump fat are more likely to have more mature reproductive tracts at breeding.

Introduction

Female fertility is one of the most economically important traits to the cow-calf producer. It has been shown by several researchers that selection for improved carcass composition in slaughter cattle may impact the fertility of their herd-mate sisters. Research has shown that a pre-breeding reproductive tract score can predict pregnancy rate. The objective of this study was to determine the relationship between reproductive traits and body composition traits as measured by ultrasound in beef heifers.

Materials and Methods

Serial ultrasound data were collected on 180 1998-born Angus heifers that were a part of the Iowa State University Rhodes Research Farm Breeding Project. These heifers were scanned by certified technicians at an average of 268, 303, 370 and 405 days of age. Data collected included weight at scanning (WT), ribeye area (REA), rump fat (RUMP), fat over the 12-13th rib (RIB) and percentage intramuscular fat (PFAT), or fat within the loin muscle. Heifers were scored at approximately 344 days for the maturity of their reproductive tracts (Table 1). Scores ranged from one to five, with one having an immature tract with no structures on the ovaries, and five having a mature tract with a corpus luteum present, which indicates a previous estrus cycle. A cycling score (CY) was assigned based on the RTS. Heifers that had a four or a five were considered to be cycling, and those with a three or less were not. Other data collected included pregnancy status after the breeding season (PREG), the number of services to conception of AI-bred heifers (SERVE) and whether or not the heifer delivered a live calf (CALVE).

Five serial scans were performed on seventy 1999-born heifers. Instead of using a one to five RTS, a cycling score (cycling or not) was assigned at an average of 369 days of age. Heifers were also observed for at least thirty minutes twice a day to determine if they had had a visible heat cycle before breeding (ESTRUS).

Data were analyzed by the general linear model of SAS. A linear and quadratic within animal regression was fitted to each composition trait. These regressions were used to adjust the ultrasound data back to the age at which each individual heifer was evaluated for RTS, and to a 395 day endpoint, which is the standard for Angus heifers in the industry, and a good estimate of pre-breeding status.

Results and Discussion

1998-born

Table 2 shows the least squares means by RTS for WT. At the age at which each heifer's RTS was taken, there were no significant differences by either method (P > .15). If the weights were taken out to pre-breeding, heavier heifers had more mature reproductive tracts (P < .05). For each individual scan weight, there was no significant relationship between WT and RTS; however, the trend was that the association gradually became more significant as the heifers matured. There was no significant relationship between WT at any time and CY, PREG or CALVE (P > .42).

Rump fat followed the same pattern as WT (Table 3). There was no significant relationship between RTS and RUMP when fat was adjusted to the age at which RTS were measured (P > .20). When adjusted to pre-breeding age, heifers with greater amounts of rump fat were more likely to have more mature reproductive tracts (P < .05). Serial scans for RUMP also showed the same pattern as WT, gradually becoming more significant as the heifers matured. By 405 days the relationship between RUMP and

RTS was nearing significance. There was no significant relationship between RUMP and CY, PREG or CALVE (P > .20).

The only variable that showed an association with REA was CY (Table 4). Heifers that were cycling at approximately one year tended to have larger ribeyes at breeding time (P < .1). This could be a function of weight. Heavier heifers have larger ribeyes. As with WT, the relationship between CY and REA seemed to increase with age.

There was no relationship between RIB or PFAT with RTS, CY, PREG or CALVE (P > .13). It is interesting that there was a relationship between RTS and RUMP, but not RIB. It could be that RUMP is a more highly heritable, repeatable measurement with a higher mean level than RIB. There is also more variation in younger, leaner cattle for RUMP than for RIB.

When the categorical variables were tested against each other, the only significant relationship was between PREG and CALVE (Table 5). There was no relationship between RTS or CY and SERVE, PREG or CALVE.

1999-born

When adjusted to the age at which each heifer was evaluated for cycling score and to 395 days by both the linear and quadratic methods, heavier heifers were more likely to be cycling (P < .06) (Table 6). Cycling score at one year was related to weaning weight and 396-day weight (P < .05). This shows that it may be possible to predict at weaning which heifers will be cycling at one year of age. Throughout the entire post-weaning period, heavier heifers were more likely to have an estrus cycle before breeding (P < .1).

The relationship between RUMP and reproductive tract maturity in the 1999-born heifers was not as strong as with the 1998-born heifers (Table 7). One possible explanation is that the 1999-born heifers were more heavily conditioned than the 1998-born heifers. The relationship between RUMP and CY throughout the post-weaning period was similar to the relationship between WT and CY over the same period. Heifers that were fatter at weaning were more likely to be cycling at one year of age (P < .05). There was no relationship between RUMP at one year or at 395 days and exhibition of estrus by breeding (P > .35). The association between RUMP and ESTRUS was most significant shortly after weaning, and then decreased.

Unlike in 1998, there was no significant association between REA at one year or 395 days and CY (P > .14) (Table 8). The individual scans show an inconsistent relationship between CY and REA at the different ages. Heifers that exhibited a pre-breeding estrus had larger ribeyes at approximately one year and at 395 days when adjusted by the quadratic method (P < .05). There is a significant relationship between ESTRUS and REA from weaning to breeding (P < .05). Again, this is probably related to weight. Heavier heifers have larger ribeyes. As with the 1998-born heifers, there was no significant relationship between RIB or PFAT and CY or ESTRUS (P > .13).

Implications

Heifers that are farther along in growth and development, as evidenced by heavier weights, larger ribeyes and more rump fat, are more likely to have higher reproductive tract scores and to be cycling at one year of age.

Table 1. Reproductive tract score (RTS) determined by palpation and ultrasound at an average of 344 days.

	Horns	Ovaries (mm)			Ovarian
RTS	(mm)	Length	Height	Width	structures
1	<20	15	10	8	no follicles
2	20-25	18	12	10	8 mm follicles
3	25-30	22	15	10	8-10 mm follicles
4	30	30	16	12	>10 mm follicles
5	>30	>32	20	15	corpus luteum present

Table 2. Least squares means by RTS for WT (kg) adjusted to the age RTS were taken and to 395 days by the linear and quadratic methods and for WT (kg) at 268, 303, 370 and 405 days, 1998-born heifers.

RTS	Lin	L395	Quad	Q395	WT1	WT2	WT3	WT4
2	310.4	362.0	309.2	363.2	238.3	259.2	344.9	370.1
3	319.0	377.2	316.2	378.5	240.0	265.8	353.5	385.9
4	324.8	379.5	323.1	379.8	243.9	271.7	361.0	391.5
5	334.2	395.6	331.7	397.3	250.2	278.5	371.7	404.4
P-value	.1556	.0292	.2322	.0172	.3737	.2471	.1906	.0785

Table 3. Least squares means by RTS for RUMP (cm) adjusted to the age RTS were taken and to 395 days by the linear and quadratic methods and for RUMP (cm) at 268, 303, 370 and 405 days, 1998-born heifers.

RTS	Lin	L395	Quad	Q395	RUMP1	RUMP2	RUMP3	RUMP4
2	.49	.61	.45	.62	.36	.37	.53	.65
3	.53	.69	.49	.70	.36	.37	.60	.73
4	.51	.66	.48	.66	.32	.35	.59	.72
5	.56	.74	.52	.76	.34	.39	.63	.80
P-value	.2045	.0353	.3677	.0156	.5199	.4454	.3662	.0533

Table 4. Least squares means by CY for REA (cm^2) adjusted to the age RTS were taken and to 395 days by the linear and quadratic methods and for REA (cm^2) at 268, 303, 370 and 405 days, 1998-born heifers.

	Lin	L395	Quad	Q395	REA1	REA2	REA3	REA4
Cycling	54.8	64.3	54.8	64.6	40.0	48.0	59.0	67.0
Not cycling	53.0	62.0	52.7	62.2	39.1	46.9	56.3	64.5
P-value	.1052	.0719	.1163	.0769	.4469	.3577	.0587	.0969

Table 5. P-values for Chi-square tests between variables, 1998-born heifers.

	RTS	CY	SERVE	PREG	CALVE
RTS			.547	.840	.812
CY			.483	.955	.823
SERVE	.547	.483		.245	.236
PREG	.840	.955	.245		.001
CALVE	.812	.823	.236	.001	

Table 6. Least squares means by CY and ESTRUS for WT (kg) adjusted to the age CY were taken and to 395 days by the linear and quadratic methods and for WT (kg) at 198, 258, 292, 334, 362 and 396 days, 1999-born heifers.

	Lin	L395	Quad	Q395	WW	WT1	WT2	WT3	WT4	WT5
Cycling	422.0	454.1	421.9	455.3	241.5	289.9	331.0	379.6	410.9	456.5
Not cycling	403.4	434.3	404.4	429.6	224.1	275.4	316.4	368.3	401.7	429.7
P-value	.0369	.0339	.0531	.0052	.0284	.1079	.1100	.2162	.3190	.0035
Estrus	416.4	443.8	416.8	443.1	236.1	289.0	328.3	378.6	410.5	447.2
No estrus	396.8	441.7	397.6	435.4	218.3	259.6	305.6	356.8	390.9	424.8
P-value	.0675	.8525	.0765	.4928	.0589	.0056	.0345	.0413	.0708	.0408

Table 7. Least squares means by CY and ESTRUS for RUMP (cm) adjusted to the age CY were taken and to 395 days by the linear and quadratic methods and for RUMP (cm) at 198, 258, 292, 334, 362 and 396 days, 1999-born heifers.

	Lin	L395	Quad	Q395	RUMP1	RUMP2	RUMP3	RUMP4	RUMP5
Cycling	.86	.93	.86	.94	.61	.65	.79	.81	.95
Not cycling	.78	.85	.78	.85	.44	.59	.72	.74	.87
P-value	.1088	.1242	.1224	.1106	.0167	.1703	.1306	.1886	.0970
Estrus	.82	.88	.82	.88	.58	.64	.74	.78	.91
No estrus	.80	.93	.80	.94	.47	.53	.72	.74	.91
P-value	.7493	.3687	.7325	.3545	.0207	.0513	.3505	.5540	.9985

Table 8. Least squares means by CY and ESTRUS for REA (cm^2) adjusted to the age CY were taken and to 395 days by the linear and quadratic methods and for REA (cm^2) at 198, 258, 292, 334, 362 and 396 days, 1999-born heifers.

	Lin	L395	Quad	Q395	REA1	REA2	REA3	REA4	REA5
Cycling	75.3	79.7	75.4	77.4	55.0	64.9	72.3	72.7	78.3
Not cycling	73.0	78.0	73.3	76.8	50.1	62.5	68.5	68.7	77.9
P-value	.1482	.2652	.1808	.6904	.0126	.2807	.0363	.0197	.8010
Estrus	75.3	79.4	75.4	78.0	53.7	65.0	71.3	71.6	79.5
No estrus	69.8	76.7	70.4	73.7	47.6	58.9	66.9	67.1	73.2
P-value	.0034	.1313	.0063	.0141	.0089	.0161	.0369	.0270	.0008