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Investigating RFI and diet interactions upon ADG, body weight, rib and back fat thickness in pregnant Angus heifers

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Introduction

Residual Feed intake (RFI) is associated with energy metabolism whereby low RFI (high efficient) animals require less energy and produce less methane per pound of gain than high RFI (low efficient) animals [1]. The selection for low RFI has an impact on the way an animal acquires, metabolizes and distributes energy, though all of the underlying changes and mechanisms are not yet fully understood [2,3]; the impact, whether positive or negative, of breeding for low RFI animals on other traits such as fertility, health and longevity is even lesser known.

Within the beef industry, the concern for maternal nutrition during the early to mid-stages of pregnancy has typically been low. In recent years, research has highlighted the influence of nutritional restriction during pregnancy on metabolism and the overall well-being of the offspring [4]. Consequently, pre-natal nutrition and selection for RFI may influence the same biological processes.

Any impairment to muscle development or myogenesis could be detrimental to the producer since the beef industry is dependent on carcass yield and muscle mass. Restriction of nutrients during the early stages of pregnancy has been shown to be one such factor that can affect myogenesis [4]. Permanent and heritable changes to the way a gene is expressed can occur in animals that experience maternal malnutrition in utero [5]. The genetic sequence is not altered by these changes, however downstream processing and modification of that gene is affected [5]. One such example is the methylation status of insulin-like growth factor-2 (IGF2), a protein hormone known to be extremely important during muscle development and fetal growth [6,7]. IGF2's methylation status has been found to be affected by prenatal nutrition in humans [8]; therefore it is a potential candidate to investigate epigenetic change brought about by nutrition in-utero.

Therefore, the objectives of this study were:

- To investigate the impact of nutritional restriction during early gestation on maternal growth and development;
- To investigate the effect and interaction between RFI and dietary treatment on phenotypic characteristics.

Materials and Methods

- Sixty-three purebred Angus heifers were tested for RFI in GrowSafe™ System [9] at the U of Alberta Kinsella ranch. They were distributed into positive (N=32) and negative (N=31) RFI groups.
- The heifers from each RFI group were bred through AI to one of two bulls with the same RFI classification to produce calves with divergent genetic potential for RFI.
- After a positive pregnancy diagnosis via ultrasound at 30 days gestation, the positive and negative RFI heifers were equally divided into 1 of 2 diet groups; the high diet (H-diet) formulated for the heifers to gain 0.7 kg/day, or the Low-diet (L-diet), formulated for heifers to grow 0.5 kg/day. Therefore there were four treatment groups: positive RFI and high diet (N=14), positive RFI and low diet (N=15), negative RFI and high diet (N=16), and negative RFI and low diet (N=15).
- Treatment diets were fed until 150 days gestation, and were adjusted to account for heifer growth.
- Throughout the trial and until approximately 220 days gestation, body weight and fat thickness measurements were obtained and recorded. Back fat and rib fat thickness measurements were obtained using an Aloka SSD-210 portable ultrasound.
- Changes in body fat and heifer weight were analyzed for effects RFI and diet as well as their interactions using PROC MIXED in SAS.

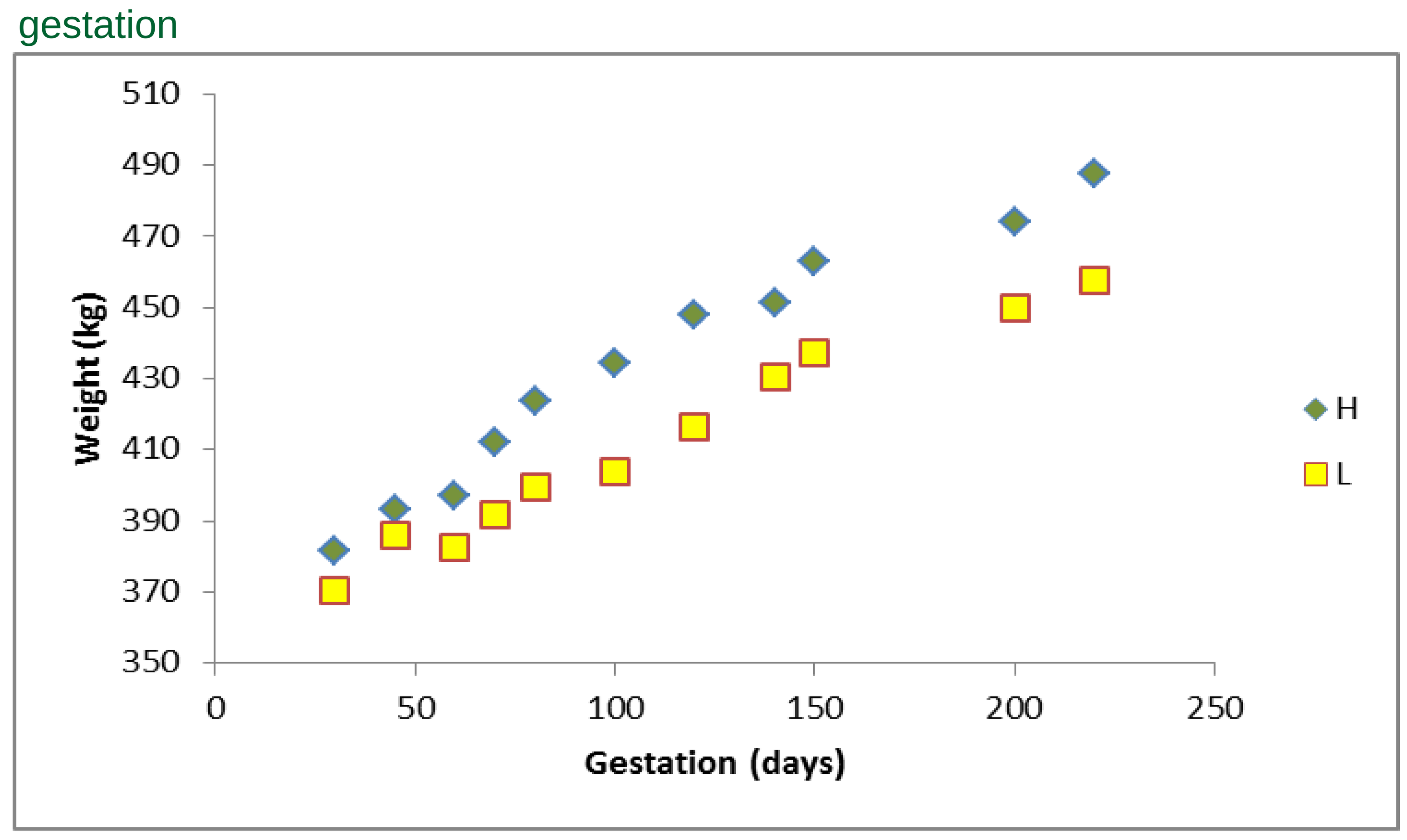
Results

Table 1: Phenotypic characteristics of pregnant heifers from studied population (n=60)

Trait	Treatment		P-value
	High diet*	Low diet*	
Start weight (kg)	383.1 ± 7.65	371.8 ± 6.43	0.2354
Initial Rib fat thickness (mm)	3.0 ± 0.18	2.7 ± 0.21	0.8303
Initial Back fat thickness (mm)	4.6 ± 0.31	3.4 ± 0.28	0.5290
Weight ~150 d gestation (kg)	456.1 ± 8.46	425.4 ± 6.94	0.0060
Rib fat ~ 150 d gestation (mm)	5.3 ± 0.14	4.3 ± 0.18	<0.0001
Back fat ~ 150 d gestation	6.4 ± 0.22	4.8 ± 0.24	<0.0001
Change in Rib fat (trial) (mm)	2.3 ± 0.14	1.7 ± 0.15	0.0002
Change in Back fat (trial) (mm)	1.8 ± 0.22	1.4 ± 0.21	0.0004
ADG during trial (kg/day)	0.59 ± 0.03	0.44 ± 0.02	0.0002
Weight ~220 d gestation (mm)	487.5 ± 8.01	457.8 ± 6.98	0.0069
Rib fat ~ 220 d gestation (mm)	4.6 ± 0.18	4 ± 0.22	0.0192
Back fat ~ 220 d gestation (mm)	5.1 ± 0.26	4.1 ± 0.25	0.0049
Change in Rib fat (150-220 d) (mm)	-0.7 ± 0.14	-0.4 ± 0.14	0.1400
Change in Back fat (150-220 d) (mm)	-1.3 ± 0.13	-0.7 ± 0.14	0.0044
ADG from 150 d -220 d gestation (kg/day)	0.42 ± 0.04	0.43 ± 0.03	0.8649
Change in ADG after trial (kg/day)	-0.17±0.07	-0.01±0.04	0.0379

*data are expressed as LSM±SEM

Figure 1: Weight gain of H- and L-diet groups from 30 days to 220 days gestation



Discussion

- Analysis of phenotypic characteristics revealed significant effects of diet treatments (Table 1). The heifers who received the diet formulated to gain 0.5 kg/day had lower final weight and ADG then those fed the diet formulated to gain 0.7 kg/day (typical target gain for physiological state of these heifers). Though there was a significant difference in ADG for the two diet treatments over the course of the trial (0.59 ± 0.03 kg/day and 0.44 ± 0.02 kg/day, H- and L-diet respectively), these ADG were below the original targets of 0.7 and 0.5 kg/day. Despite the discrepancy between predicted and actual ADG, differing final weights between dietary treatments was still observed (Figure 1).
- There were changes observed in fat thicknesses during the trial that mimicked the trend of changes in weight and ADG. Studies have shown that subcutaneous fat such as back fat and rib fat, are more susceptible to changes in nutrient supply than other types of fat stores [10,11].
- At the conclusion of the trail (150 days gestation) to approximately 220 days gestation, the ADG was very similar for both groups. No significant change was observed in the ADG of the heifers from L-diet, but the heifers from the H-diet saw a significant decrease. At the trial's end, the heifers went from feedlot-like conditions to free-choice hay and fed the same ration as other pregnant heifers, which is the likely causation of the change in ADG.
- Body weight and fat thicknesses of H-diet and L-diet heifers were still significantly different at 220 days gestation, with the animals from H-diet weighing more and having thicker fat measurements than L-diet.
- The growth and development of efficient and inefficient animals did not differ between dietary treatments. This is not a surprising result as RFI is a measure of efficiency of gain, not of gain itself. The negative RFI animals, in theory, would have consumed less feed for the same gain as the positive RFI animals. This advantage and the variance in RFI disappear however when fed a restricted diet [12]. In order to truly analyze the effects of RFI in this study, heifer intakes during the course of the trial will be taken into consideration.

Conclusion

Dietary treatment did have significant impacts upon the heifers' physiological state, as observed via ADG, body weight and fat thickness. No significant differences were observed between positive and negative RFI heifers, nor was there evidence of significant interaction between RFI and diet. Analysis of intake data may detect influences of the animals' RFI.

With clear differences between treatments, our next step is to determine if these effects are translated to the fetuses. Phenotypic differences between calves from the restricted and unrestricted diets will be evaluated, along with their RFI. It will be determined if nutrient insult in utero has the ability to change RFI potential and if there are any long term effects in terms of growth and development. Epigenetic changes brought about by these dietary treatments will also be investigated through the methylation status and expression of IGF2.

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