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Effects of a high rate of gain for increasing lengths of time on body and mammary growth in prepubertal dairy heifers*

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ABSTRACT

Our objective was to determine effects of feeding prepubertal heifers (n=16/trt) for rapid gains for different lengths of time (0, 3, 6, 12 wk) on body and mammary growth. Increasing time on the high diet increased mass of carcass and extraparenchymal mammary fat but did not alter mammary parenchyma weight. Increasing time on the high diet decreased mass of mammary parenchyma per kg carcass in a linear fashion. Although mass of parenchyma was not decreased by feeding the high diet for only 3 or 6 wk, changes were consistent with impaired growth seen with 12 wk of the high diet.

KEY WORDS: heifers, growth, mammary, rate of gain

INTRODUCTION

Rapid growth rates enable heifers to calve earlier and reduce costs associated with raising replacement heifers. But, mammary development and milk yield potential are hindered when prepubertal dairy heifers are fed for a high rate of gain for lengths of time greater than 3 months (Sejrsen et al., 1982; Petitclerc et al., 1999; Radcliff et al., 2000). However, the effects of a high rate of gain for shorter periods have not been reported. The objective of this study was to determine the effects of feeding for a high rate of gain for different lengths of time on body and mammary growth in prepubertal heifers. We hypothesized that short-term high rates of gain (3, 6 wk) either increase or are not detrimental to growth of

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mammary parenchyma, but long-term high rates of gain (12 wk) are detrimental to mammary parenchyma growth in prepubertal heifers.

MATERIAL AND METHODS

Holstein heifers (n=64, age=11 wk, BW=107 kg, SE=1.0) were randomly assigned to 1 of 4 treatments: H0 (low diet fed for 12 wk); H3 (low diet fed for 9 wk followed by high diet for 3 wk); H6 (low diet fed for 6 wk followed by high diet for 6 wk); and H12 (high diet fed for 12 wk). The high diet was fed to achieve 1.2 kg average daily gain (ADG) and consisted of 20% immature lucerne silage, 20% maize silage, and 60% concentrate on a DM basis. The high diet was 1.17 Mcal/kg NEg, 18.4% CP, and 22.6% NDF. The low diet was fed to achieve 0.6 kg ADG and consisted of 10% straw, 33% mature lucerne silage, 33% oatlage, and 24% concentrate on a DM basis. The low diet was 0.77 Mcal/kg NEg, 16.4% CP, and 43.6% NDF. Both diets were available *ad libitum*.

During the treatment period, body weight was taken weekly and withers height was taken every 2 wk. Heifers were slaughtered at 23 wk of age. Mammary glands were frozen and cut into 5- to 10- mm slices. Slices were processed and parenchymal and extraparenchymal tissues were dissected and weighed as described (Radcliff et al., 1997). As is standard in studies on mammary growth, mammary data were adjusted for body weight. For our adjustment, we expressed mammary data on a carcass basis so that we could examine mammary growth relative to carcass growth for each treatment.

Statistical analysis used the GLM procedure of SAS and tested comparisons using linear, quadratic and cubic contrasts. Statistical significance was declared at $P<0.05$, and tendency at $P<0.10$.

RESULTS

Average daily gain and final body weights were different for all comparisons except H0 vs H3 (Table 1). However, carcass weights were different for all comparisons. Withers height increased for heifers fed the high diet for 6 and 12 weeks. Perirenal fat and mammary hemigland weights increased linearly with time on the high diet. Although the high diet did not decrease the total mass of mammary parenchyma (data not shown), the high diet tended to decrease parenchymal mass relative to carcass mass. Mammary extraparenchymal fat increased as time on the high diet increased (data not shown) and was also true when adjusted for carcass weight. This indicates impaired mammary development. An increase in body growth without a proportional increase in mammary growth would result in less mammary parenchyma at puberty because heifers fed for rapid growth attain puberty earlier.

Table 1. Effect of different lengths of time on a high diet on body and mammary growth of prepubertal dairy heifers

Item	Diet				SE	Linear	Quad-ratic	Cubic
	H0	H3	H6	H12				
ADG, g/d	662	660	848	1124	12	<0.001	<0.001	<0.001
ADG, last 2 wk, g/d	716	1025	1340	1205	85	<0.01	<0.01	---
Bodyweight, at slaughter, kg	165	166	181	203	1	<0.001	<0.01	<0.01
Withers height, last 2 wk, cm	100	100	102	104	0.3	<0.001	---	0.05
Carcass, kg	77	82	92	107	1	<0.0001	---	0.05
Perirenal fat, g/100 kg carcass	900	1181	1608	1794	105	<0.0001	---	---
Hemigland, g/100 kg carcass	529	591	768	864	43	<0.001	---	---
Parenchyma, g/100 kg carcass	95	92	91	78	6	0.06	---	---
Extraparenchyma, g/100 kg carcass	139	179	238	297	22	<0.001	---	---

DISCUSSION

Short term changes in diet altered growth of body and mammary tissues. Body weights were not different between H0 and H3 but carcass weight was altered, probably due to differences in gut fill. This was the reason for adjusting other measurements on a carcass basis instead of a body weight basis. Results from this current study are similar to those reported previously in that the high diet increased fat deposition in extraparenchymal fat and this was also found to be evident in perirenal fat. Parenchymal tissue adjusted for carcass weight also followed a similar trend to that reported in the literature (Sejrsen et al., 1982; Petitclerc et al., 1999). However, analysis of mammary tissue composition is ongoing and must be completed before final conclusions are made.

CONCLUSIONS

We conclude that short term (3 or 6 wk) increases in dietary energy do not improve mammary growth but rather alter growth of body and mammary tissues in a manner consistent with long term (12 wk) feeding of a high energy diet.

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