Livestock Science 146 (2012) 140–148

Contents lists available at SciVerse ScienceDirect

Livestock Science

journal homepage: www.elsevier.com/locate/livsci

Effect of supplementation of beef steer diets with oil containing n6 and n3 fatty acids and 48 h feed withdrawal treatments on plasma hormone profiles and adipose tissue cellularity ☆

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ARTICLE INFO

Article history:
Received 28 September 2011
Received in revised form
29 February 2012
Accepted 1 March 2012

Keywords:
Adipose cellularity
Dietary oil
Periodic feed withdrawal
Plasma glucose
Plasma hormone profile

ABSTRACT

A 2 × 3 factorial experiment was conducted with 72 weanling, crossbred steers (with Hereford, Angus and Charolais genetics and initial BW of 280.5 ± 5.8 kg) with the objective of determining the effect of dietary and feed withdrawal (FW) treatments on plasma concentrations of glucose, insulin, growth hormone (GH) and leptin and on intramuscular and subcutaneous (SQ) adipose cellularity. Supplementation was a 50/50 mixture of flax and sunflower oil at 5% of diet (OIL) versus a control (CON; without oil) diet, which were the dietary treatments and were applied to steers experiencing three feed withdrawal (FW) treatments. The FW treatments were no FW, a single 48 h FW (FW × 1) before initiation of fattening at one year of age or 48 h FW at 8 week intervals from weaning to initiation of fattening (FW × 4). Plasma was harvested from jugular blood collected from all steers after each FW and samples of *pars costalis diaphgramatis* (PCD) muscle and SQ from the brisket were collected from the steers at slaughter for adipocyte enumeration. Cell number was determined by computerized image enumeration and electronically by a particle counter. Plasma concentrations of glucose and hormones responded to age of steers at the time of sample procurement (P=0.001–0.053), and a diet × FW interaction (P=0.015) was observed for insulin, because steers fed the OIL diet in the FW × 4 treatment had lower insulin concentrations than of those in the other FW treatments. Concentrations of growth hormone (GH) decreased (P=0.028) due to FW from 7.17 ± 1.02 ng/mL in steers in the no FW treatment to 5.04 ± 0.78 and 5.46 ± 1.22 ng/mL for steers in FW × 1 and FW × 4 treatments, respectively. Leptin concentrations were unaffected by diet or FW treatment. The relationship for cells enumerated by the particle counter versus the Motic computer program was significant (P=0.01) for both PCD and SQ fat with r^2 values of 0.55 and 0.24, respectively, for total cells of diameters from 30 to 300 μm. Number of adipocytes with diameters from 80 to 140 μm in the PCD were greater (P=0.038 and 0.028) in OIL than in CON fed steers. The percent of total number of cells in the 30–60 μm diameter range in the PCD were greater in steers in FW × 1 and FW × 4 than in no FW treatments when counted by either

☆ Lethbridge Research Centre Contribution.

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1871-1413/$ - see front matter
http://dx.doi.org/10.1016/j.livsci.2012.03.001

method. Provision of dietary oil and FW treatments had no effect on plasma metabolites and may be the reason for the absence of a response in total adipocyte numbers due to FW.

1. Introduction

Carcass marbling scores of cattle that underwent feed withdrawal (FW) for 48 h in preparation for the intravenous glucose tolerance test were greater and a larger percentage of these carcasses exhibited "Canada AAA" or the equivalent "US Choice" grades than cattle not subjected to FW (Mir et al., 1998; 2002). Furthermore, 81% of heifers subjected to a 48 h FW before initiation of fattening at the age of one year yielded carcasses that graded "Canada AAA" while only 68% of heifers not subjected to FW obtained the same grade, leading to an odds ratio of 1.84 for better grades by applying the FW treatment (Mir et al., 2008). In the study with heifers, adipocytes less than 35 μm in diameter could be enumerated and it was expected that FW would increase small adipocytes, but the effect of FW on steer adipocytes has not been documented. Enumeration of adipocytes has been accomplished electronically using particle counters (Smith et al., 2007) or by computerized image analysis (Schoonmaker et al., 2004; Yang et al., 2006) yet neither a comparative assessment of the methods, nor the effect of factors such as dietary oil (can affect relative adiposity in cattle; Shah et al., 2006) and FW treatments on adipocyte density and size in cattle has been presented. The present study was undertaken to evaluate the hypothesis that FW and dietary oil affected adipogenesis, via changes in hormone post FW and that dietary oil could affect these alterations. Thus the objectives of the present study were to determine the effect of FW in steers fed the control (CON) and oil (OIL) containing diets (He et al., 2011) on plasma concentrations of glucose, insulin, growth hormone (GH) and leptin, because FW affects metabolism via hormones (Mir et al., 2008), and to compare cellularity of fat dissected from the *pars costalis diaphgramatis* (PCD) muscle and subcutaneous adipose (SQ) from the brisket of steers when determined using both the particle counter (Mir et al., 2008) and the computerized image analysis program (He et al., 2010).

2. Materials and methods

2.1. Animals and diets

A total of 72, spring born, European crossbred (with Hereford, Angus and Charolais genetics), steer calves were obtained upon weaning (280.5 ± 5.8 kg) and housed in the Individual Feeding Barn of the Lethbridge Research Centre following the guidelines of the Canadian Council on Animal Care (2003). The study was started after receiving approval of the Institutional Animal Care Committee (Approval#0727). The vaccination protocol, treatment assignment and diets fed to the steers have been provided in He et al. (2011). Calves were not implanted or provided growth promoters in the feed to avoid any effects on hormone profiles of the steers, which could be affected by the treatments imposed on the animals.

Six treatments were applied to the steers in a 2×3 factorial arrangement (Fig. 1), where each of two diets was provided to the steers undergoing one of three FW treatments, where each FW lasted for 48 h, but water was available. The steers were fed either the CON or the OIL diet. In the OIL diet, 5% of the diet was replaced with an equal mixture of flax and sunflower oil. The oil replaced the steam rolled barley in the diet (He et al., 2011). The FW treatments were no FW, single FW (FW × 1, Mir et al., 2008) at yearling age; just before initiation of the fattening phase or 48 h FW every 8 week, which occurred four times (FW × 4), between start of the experiment and until they were approximately a year old and before the transition to the fattening phase was initiated. Each FW was started on the weigh day after recording the BW and cleaning the feed bunks for all the steers. Only those in the FW treatment did not receive the feed after recording the BW. After the 48 h FW, jugular blood samples were collected from all steers (irrespective of whether they had undergone a FW or not) before providing the steers with the respective diets.

The animals were fed once daily with total mixed rations. Animals were weighed every 4 week through the growing phase and every 3 week during the fattening phase. At the end of the trial when steers were judged visually by the commercial abattoir purchaser as carrying adequate fat to yield 57% lean meat, the animals were weighed on full feed on two consecutive days and shipped on full feed and processed at a commercial abattoir (He et al. 2011).

2.2. Blood sample procurement and processing

Post FW and before providing the steers with feed, jugular blood was collected in two, 7 mL evacuated glass

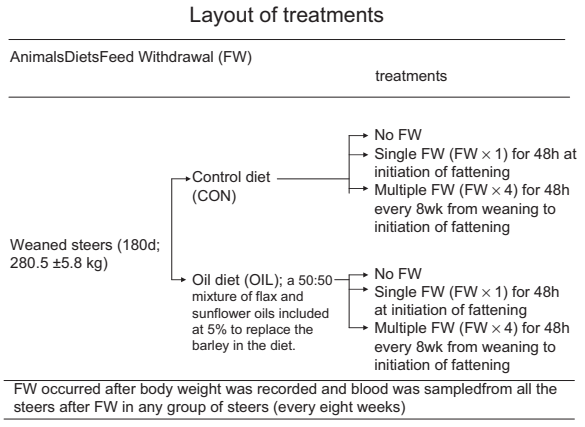

Fig. 1. Schematic of the experimental protocol employed.