Livestock Science 157 (2013) 462–470

Contents lists available at ScienceDirect

Livestock Science

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

Low crude protein diets and phase feeding for double-muscled crossbred young bulls and heifers

S. Schiavon, F. Tagliapietra, G. Cesaro *, L. Gallo, A. Cecchinato, G. Bittante

Department of Agronomy, Food, Natural Resources, Animals and Environment (DAFNAE), University of Padova, Viale dell'Università 16, 35020 Legnaro (PD), Italy

ARTICLE INFO

Article history:
Received 12 April 2013
Received in revised form
23 August 2013
Accepted 20 September 2013

Keywords:
Beef production
Carcass quality
Double-muscled crossbreds
Low protein diets
Meat quality

ABSTRACT

This study aimed to evaluate the effect of underfeeding dietary crude protein (CP) during the whole or part of the fattening period on growth performance, dry matter intake (DMI), carcass and meat quality traits of crossbred bulls and heifer calves obtained from double-muscled (DBM) Belgian Blue (BB) sires and dairy or dual purpose cows. Twenty-four crossbred BB sired young bulls and 30 BB sired heifer calves (236 ± 27.0 kg BW) were housed in 12 pens with males separated from heifers. They received a control diet (CP14) with 140 g CP/kg DM for the whole experiment (CP_{HH}) or a low-protein diet (CP10) with 102 g/kg CP/kg DM for the whole experiments (CP_{LL}) or CP14 for the first 90 days and CP10 for the remaining days (94 days on average) of finishing period till slaughtering (CP_{HL}), which occurred when heifers and bulls reached 485 and 535 kg BW, respectively. Compared to CP_{HH} and CP_{LL} calves, CP_{HL} animals evidenced faster ADG ($P < 0.05$), albeit the magnitude of this effect was limited (on average +6.3%). During the whole trial no differences among groups were observed for DM intake (8.9 kg/d), gain:feed ratio (0.144), carcass weight (301 kg), carcass yield (589 g/kg BW), SEUROP carcass muscularity (U+) and for most of the meat quality traits. Only meat shear force was increased ($P = 0.04$) by CP_{LL} treatment compared to CP_{HH} and CP_{HL} (+17%). Bulls and heifers differed for growth performance and for many carcass and meat traits, but gender did not interact with dietary treatment for any trait. It was concluded that little benefits would be achieved using CP14 for the entire or part of the fattening period on these crossbreds. Beside, this paper covers a lack of information about quality traits of crossbred heifers and young bulls obtained from DBM BB sires and dairy and dual purpose dams showing that carcass and meat quality traits of these subjects are comparable or better than those achievable from non-DBM beef breeds cattle.

1. Introduction

The use of low-protein diets and phase feeding are gaining interest in beef fattening because of the costs of protein sources and the concerns about the environmental impact of farming (Sheppard and Bittman, 2011). The European Union, with the Nitrate Directive (EEC, 1991), fixed a maximum of 170 kg N/ha as a threshold for the disposal of N in areas defined as vulnerable to nitrates. The reduction of dietary protein supply could reduce the production of the individual animal but it would largely increase farm beef production because of the possibility of reducing N excretion and increasing the number of animals fattened per unit of agricultural land (Schiavon et al., 2012). Beef cattle growth response to the amount and quality of protein supplied, has been tested on conventional breeds and some works regarded double-muscled (DBM)

* Corresponding author. Tel.: +39 049 8272777; fax: +39 049 8272784.
E-mail address: giacomo.cesaro@studenti.unipd.it (G. Cesaro).

1871-1413/$ - see front matter © 2013 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.livsci.2013.09.015

hypertrophic beef cattle breeds (De Campeneere et al., 1999a; Fiems et al., 1999; Schiavon and Bittante, 2012). Compared to other beef cattle, DBM calves have a greater potential for lean growth and a greater carcass yield due to the small proportion of the gastrointestinal tract on BW, so that higher dietary CP density, about 160 and 125 g CP/kg DM for early and late fattening period, respectively, have been suggested for these animals (Fiems et al., 1998). However, other studies found that a reduction from about 140 to 110 g CP/kg of diet impaired growth performance of DBM young bulls only during the initial fattening phase, without substantial effects on final BW, average daily gain (ADG), carcass and meat quality traits (Dal Maso et al., 2009; De Campeneere et al., 1999b; Schiavon et al., 2011). To our knowledge no information is available on crossbred calves obtained from DBM bulls mated to conventional cows. Thus, it remains unknown if or to what extent lowering the dietary CP density over the whole or a part of the finishing period would affect growth performance and carcass and meat quality traits of such kind of cattle.

Therefore, aim of this study was to evaluate the effects due to a sub-optimal dietary CP content during the whole growing-finishing cycle or only during the last finishing phase on growth performance, DM intake and feed efficiency (gain:feed ratio), carcass and meat quality traits of crossbred bulls and heifers obtained from DBM Belgian Blue sires and dairy or dual purpose cows.

2. Materials and methods

2.1. Animals

The present study is part of a project aimed to evaluate the validity of using sub-optimal dietary protein supply in purebred DBM calves or crossbred calves sired by DBM bulls for reducing N excretion (Dal Maso et al., 2009; Schiavon et al., 2010, 2011, 2012). Calves were treated following the Guideline for the Care and Use of Agricultural Animals in Agricultural Research and Teaching (Consortium, 1988) and the project was approved by the Ethical Committee for the care and the use of experimental animals of the University of Padova.

Dairy cows belonging to Brown Swiss (BS) breed, to dual purpose Simmental (Si) breed and to dual purpose autochthonous Rendena (Re) breed (Bittante, 2011), reared in the Italian alpine area in the province of Trento (Bazzoli et al., 2013), were artificially inseminated with semen of DBM Belgian Blues sires. Crossbred calves were housed and weaned in the same barn under the same feeding and housing conditions. Thirty-two DBM sired young bulls and 30 DBM sired heifers (236 $\pm$ 27.4 kg BW) were selected on the basis of their maternal breed, age and BW and moved to the experimental farm "Lucio Toniolo" of the University of Padova to be used in the current experiment.

At their arrival the calves were housed in 14 fully slatted floor pens with four bulls or five heifer calves each. The first and the last pen on the opposite sides of the barn, both with male calves, were considered as border pens, and were excluded from data analyses. These two pens were planned not to be included in the experiment first because they grouped animals with BW not homogeneous with those of the experimental pens, second to minimize possible border effects due to their position in the barn. Thus, 6 pens with 4 males each and 6 pens with 5 females each were used. In each pen for males, two Belgian Blue $\times$ BS, one Belgian Blue $\times$ Si and one Belgian Blue $\times$ Re young bulls were housed; whereas in the pens for females three Belgian Blue $\times$ BS, one Belgian Blue $\times$ Si and one Belgian Blue $\times$ Re heifers were housed. The calves were vaccinated against bovine rhinotracheitis, parainfluenza$_3$, and bovine respiratory syncytial viruses and injected with 2.5 mg/kg BW of Tulathromycin, and were fed a transition diet for 40 d in which meadow hay was progressively replaced by a diet containing 140 g CP/kg DM.

2.2. Feeding treatments

Three feeding treatments were compared in this experiment. In a first treatment (CP_{HH}) the calves were fed for the entire duration of the trial, till slaughter, a total mixed ration (TMR) with a conventional high 139 g/kg DM CP content (CP14). In a second treatment (CP_{LL}) the calves were fed for the entire duration of the trial a TMR containing only 102 g CP/kg DM (CP10). In the third treatment (CP_{HL}) the calves were kept for 90 days on CP14 and for the rest of finishing period till slaughter (94 days on average) on CP10. Each feeding treatment was tested on 4 pens, two of males and two of females. The CP14 and CP10 TMR had the same ingredient composition (Table 1) of the two diets used in a previous trial conducted on purebred DBM Piemontese young bulls (Schiavon et al., 2010, 2012). The CP10 ration was formulated from the CP14 one by reducing the level of inclusion of soybean meal from 126 to 33 g/kg DM and accordingly increasing all the other ingredients.

In order to minimize differences of composition among treatments a common basal diet, corresponding to the composition of CP10 ration, was prepared daily using a mixer-wagon equipped with a computer assisted weighing scale, calibrated monthly. After the distribution of the CP10 ration to each corresponding pens, the amount of soybean meal required to reach the 140 g CP/kg DM of CP14 ration was added to the mixer wagon, mixed with the other ingredients and distributed to each of the remaining CP14 pens.

The amount of each feed ingredient loaded into the mixer-wagon and the weight of the mixture uploaded in the manger of each pen were recorded daily. The orts remained in the mangers were weighed and sampled by pen weekly. As animals in pens were not fed individually, DMI and feed efficiency were computed on pen basis.

Samples of each feed ingredient of diets and of orts were analyzed for their proximate composition (AOAC, 2000) and their NDF, ADF, ADL and AIA content (Van Soest et al., 1991). Metabolizable energy, net energy for maintenance (NEm), net energy for growth (NEg), rumen degradable (RDP) and undegradable (RUP) protein contents of the rations were computed from actual ration ingredient composition and from tabular values of each feed ingredient (NRC, 2000).