Animal Feed Science and Technology 186 (2013) 148–157

Contents lists available at ScienceDirect

Animal Feed Science and Technology

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

Effect of an energy restriction followed by a re-alimentation period on efficiency, blood metabolites and hormones in Belgian Blue double-muscled cows

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ARTICLE INFO

Article history:
Received 3 December 2012
Received in revised form
13 September 2013
Accepted 22 October 2013

Keywords:
Double-muscled cow
Energy restriction
Body weight change
Efficiency
Blood metabolites
IGF

ABSTRACT

The aim of the present study was to determine to what extent an energy restriction, followed by a re-alimentation, affects body weight (BW), feed efficiency and concentrations of blood metabolites and IGF-1 (insulin-like growth factor 1). Two experiments were conducted with 20 (initial BW 621 ± 18 (SE) kg) and 13 (initial BW 613 ± 29 kg) non-pregnant dry Belgian Blue double-muscled cows, respectively. A similar diet was fed in both experiments, consisting of maize silage, 0.5 kg per day of a vitamin–mineral premix, and urea to prevent a negative rumen degradable nitrogen balance. In experiment 1, cows were divided into 2 groups and fed an energy level (EL) corresponding to their requirements (EL100; 224 days), or 0.7 of their requirements (EL70–130) during the first 112 days (Phase 1), and 1.3 times the requirements during the next 112 days (Phase 2). Cows were weighed, scored for body condition, and blood samples were collected at 8-week intervals. Glucose, non-esterified fatty acids (NEFA), creatinine, IGF-1, IGFBP (IGF Binding Protein)-2 and IGFBP-3 were analyzed. EL70 resulted in a larger BW change compared to EL100 (−10.2% of the initial BW; $P < 0.001$) during phase 1, but BW loss was completely compensated during phase 2. Efficiency of nutrient use (gain/intake) for the restriction and the re-alimentation period as a whole was similar for both treatments ($P > 0.10$). Blood concentrations of metabolites and IGF-1, IGFBP-2 and IGFBP-3 were not affected by energy restriction ($P > 0.10$). Concentrations of glucose, NEFA, creatinine and IGFBP-3 were affected by sampling day, while a treatment × sampling day interaction was found for NEFA. In experiment 2, cows were fed at 0.8 or 1.0 of their energy requirements during 140 days, followed by a 70-day re-alimentation period, where all cows were fed *ad libitum*. EL80 resulted in a BW loss of 7.9% of the initial BW during phase 1. Average growth rate for the restriction period and the re-alimentation period together remained lower ($P = 0.014$) in comparison with cows fed according to their requirements. Furthermore, efficiency of nutrient use for the whole period was adversely affected $P < 0.05$). Therefore, feeding Belgian Blue double-muscled cows below their energy requirements should be discouraged.

Abbreviations: BBDM, Belgian Blue double-muscled; BCS, body condition score; BW, body weight; DM, dry matter; EL100, energy level corresponding with energy requirements; EL70–130, energy level corresponding with 0.7 of energy requirements during the first 112 days, and 1.3 during the next 112 days; IGF, insulin-like growth factor; IGFBP, IGF binding protein; NEFA, non-esterified fatty acids; NE, net energy for lactation.

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http://dx.doi.org/10.1016/j.anifeedsci.2013.10.016

1. Introduction

Previous experiments showed that the application of a moderate energy restriction in Belgian Blue double-muscled (BBDM) cows during an indoor period of 140 days, followed by a re-alimentation period, did not result in detrimental effects on the performance of dams and offspring, except higher calf losses (Fiems et al., 2009). The philosophy of a temporary feed restriction in suckler cows is that the use of body reserves may result in a considerable economy in feed, especially when body reserves are restored during a period of herbage growth (Petit et al., 1992), without a detrimental effect on reproductive performance and beef production capacity. Furthermore, feed restriction at 0.75–0.80 of *ad libitum* intake level increased average lifespan from 10.9 to 14.7 years in Hereford cows (Pinney et al., 1972). Freetly and Nienaber (1998) showed that cows had an increased efficiency of nutrient utilization during re-alimentation after a period of BW (body weight) loss. On the other hand, Vermorel et al. (1976) found that a restriction up to 0.75 of *ad libitum* intake resulted in a beneficial effect on feed conversion in normal-muscled growing bulls, but in a detrimental effect in double-muscled animals. Moreover, growth rate was more severely reduced in double-muscled bulls. This may be due to a reduced deposition of adipose tissue in double-muscled animals. Normally, a compensatory feed intake is realized after a restriction period, resulting in a compensatory gain (Ryan et al., 1993). However, double-muscled animals have a lower feed intake capacity than normal-muscled ones (Fiems et al., 1997), so that the capacity to compensate intake may be compromised in this type of animals. Therefore, BBDM cows may respond differently to an energy restriction compared with normal-muscled cows. As far as we know double-muscled animals mostly receive an energy-rich diet with a large proportion of concentrates after a restriction period (Hornick et al., 1998a; Fiems et al., 2002), while the intention of a re-alimentation period in BBDM cows is to make a maximum profit of the use of grass.

It is clear that the somatotrophic axis plays an important role in the coordination between the genetic potential and the nutritional limitations. The nutritional status has a marked influence on the nutrient utilization, which is partly regulated through changes in the endocrine status and fluctuations of some blood metabolites (Breier et al., 1988; Chilliard et al., 1995; Renaville et al., 2000). Several studies showed that the endocrine status of double-muscled animals may be different from that of normal-muscled ones (Michaux et al., 1982; Arthur et al., 1990; Gerrard and Grant, 1994).

The aim of the present experiments was to investigate the effect of a temporary energy restriction on BW change, efficiency and blood concentrations of metabolites and insulin-like growth factor (IGF)-1 in BBDM cows.

2. Materials and methods

2.1. Animals and diets

Two experiments were conducted with non-pregnant dry BBDM cows, confined in tie stalls. Bedding consisted of wood shavings. They were divided into 2 comparable groups, based on age, parity, BW and body condition score (BCS). BCS was determined by 2 technicians and ranged between 0 (extremely thin) and 5 (very fat). The diet consisted of maize silage and 0.5 kg/day of a vitamin–mineral premix. The content of 1 kg premix was: macro minerals (g/kg): Ca: 63, P: 51, Mg: 20, Na: 16; trace minerals (mg/kg): Co: 0.1, Cu: 11.0, Fe: 92.6, I: 0.1, Mn: 47, Se: 2.7, Zn: 35.8; vitamins (IU): A: 77,000, D3: 15,400, E: 600. Using the protein evaluation system described by Tamminga et al. (1994) urea was individually fed, so that the rumen degradable protein balance of the diet was close to 0 g/day.

The objective of experiment 1 was to investigate the nominal compensation of the reduced feed intake during a subsequent re-alimentation period. Twenty cows, with an initial age, BW and parity of 1319 ± 114 (standard error) days, 621 ± 18 kg and 2.2 ± 0.3, respectively, were subjected to one of two dietary treatments. Half of the animals were fed an energy level corresponding to their absolute daily energy requirements for maintenance, and growth in case of first and second-calf cows (EL100; 224 days). Energy level of the second group (EL70–130) amounted to 0.7 of their requirements during the first 112 days (Phase 1), and to 1.3 times of their requirements during the next 112 days (Phase 2). Energy (Net energy for lactation; NE) was based on the feed evaluation system described by Van Es (1978). The cows were weighed and BCS was estimated at 8-week intervals. A double weighing occurred at the start and the end of the experiment and at days 111 and 112.

The objective of experiment 2 was to investigate the effect of an *ad libitum* feed intake during a re-alimentation period after a restriction period with two energy levels. Fourteen cows (initial age, BW and parity of 1220 ± 143 days, 613 ± 29 kg and 1.9 ± 0.3, respectively) were involved, but one cow that became pregnant shortly before the start of the experiment was discarded. During phase 1 (140 days), 7 animals were fed according to their energy requirements (EL100). The other 6 cows were fed a restricted diet corresponding to 0.8 of their requirements (EL80). The reason for a lower energy restriction in experiment 2 compared with experiment 1 was the detrimental effect on calf survival when dams were restricted at 0.7 of their energy requirements during the indoor period (Fiems et al., 2009). This period was followed by a 70-d re-alimentation period (Phase 2), where all cows were fed *ad libitum*. During this period maize silage was freely available. The amount of urea fed was calculated to yield a dietary rumen degradable protein balance of zero according to the protein evaluation system described by Tamminga et al. (1994). This period was a simulation of the initial months of the re-alimentation period that normally takes place on pasture, where grass of good quality is abundantly available.

In both experiments refusals were weighed weekly. Protein requirements were always fulfilled during phase 1. The protein concentration of the diet remained unchanged during phase 2. Experimental procedures were according to the