

Concentrate-enriched diets for calving heifers in the periparturient period increase milk yield and improve blood metabolite profile

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ABSTRACT

The experiment was carried out on 28 Black-and-White heifers (3 groups of 8-10 animals) from 3 weeks before expected calving to 300 days of lactation. One week before calving and in the first week of lactation, the animals in the control group were fed a diet formulated according to IZ-INRA requirements (2001) to achieve a milk yield 30 kg/d at the peak of lactation. The daily ration for control animals containing 3 kg concentrate was increased for experimental group H₁ and H₂ by 1 or 2 kg concentrate, respectively. The increased feeding level reduced serum non-esterified fatty acids and β -hydroxybutyric acid, and increased the glucose concentration and milk yield during lactation.

KEY WORDS: heifers, periparturient period, feeding level, blood metabolite, milk yield

INTRODUCTION

Increased intake of concentrate during the periparturient period, 3 weeks before and 3 weeks after parturition (Holcomb et al., 2001; McNamara, 2003), can have a beneficial effect on nutrient balance in late pregnancy and early lactation (Minor et al., 1998; Olson et al., 1998; Vandehaar et al., 1999). Vandehaar et al. (1999) reported that a high energy intake is particularly important during the last four days before calving. Grummer (1993) found that the week before and after parturition is the critical period in which it is possible to counteract accumulation of fat in the liver, as this is the time when cows are most susceptible to this process. Whitaker et al. (1996) report that the

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blood metabolite profile could be a good indicator of energy deficit in preparturient and lactating cows. The aim of this study was to determine the effect of feeding above requirement (IZ-INRA, 2001) levels of energy and protein to Black-and-White heifers during the final week before calving and in the first week of lactation on the level of metabolites in blood serum and on milk production.

MATERIAL AND METHODS

The experiment was carried out on 28 Black-and-White heifers (50-87.5% HF), allotted into 3 groups of 8-10 animals, from 3 weeks before expected calving to 300 days of lactation. Animals were fed individually rations formulated according to IZ-INRA (2001) requirements to achieve a milk yield of 30 kg/d at the peak of lactation. Daily rations for the control group (C) containing 3 kg concentrate in this period were increased additionally for experimental groups H₁ and H₂ by 1 or 2 kg concentrate, respectively. Bulky feed (maize and wilted grass silage) and concentrate (%: cereals 67, soyabean meal 15, wheat bran 15, mineral mixture Lutamix, BASF 3) were given in separate feeders. Milk yield was determined daily using a model FV TRU-TEST milk meter. Blood samples were taken from the jugular vein 5 days before presumed calving and on day 10 of lactation, 2 h after the morning feeding. Non-esterified fatty acids (NEFA) in blood serum were determined colorimetrically using acyl-CoA synthetase and oxidase, β -hydroxybutyric (BHBA) acid, by using a high sensitivity kit (RANDOKS Laboratories Ltd., Co. Antrim, USA). Glucose, crude protein and albumin were estimated using a Vitros analyser, Model 700 XRP, Johnson and Johnson test Methodology Sheets (1996). Results were subjected to one-way analysis of variance (SAS, 1996, procedure GLM).

RESULTS

During a 300-day lactation, primiparous cows of group H₁ produced approximately 7% (7051 kg), and those of group H₂, 5% (6955 kg) more milk than primiparous cows of group C (6610 kg), however, the differences were not significant ($P > 0.05$). During the week before calving in group H₁, heifers consumed about 16% more dry matter and UFL and approximately 22% more CP and PDI, and those of group H₂, approximately 30 and 40%, respectively, more than control group heifers. During the week after calving, daily intake of DM, CP, PDI and UFL was higher by approximately 15 and 21% in groups H₁ and H₂, respectively, ($P < 0.05$) than in the control group. Compared with group C, the blood serum of cows from groups H₁ and H₂ showed a clear tendency towards

lower concentrations of NEFA and BHBA, and higher concentrations of glucose, CP and albumin and a higher albumin-to-globulin ratio (Table 1).

Table 1. Metabolite concentration in blood serum

Group	NEFA mmol/L	BHBA mmol/L	Glucose mmol/L	CP g/100 ml	Albumin g/100 ml	Albumin globulin
<i>Day 5th before calving</i>						
C	0.59 (0.17)	0.78 (0.22)	3.89 (0.12)	7.35 (1.86)	2.71 (0.88)	5.71 (0.18)
H ₁	0.34 (0.06)	0.68 (0.07)	4.21 (0.23)	7.90 (1.18)	2.86 (0.68)	6.00 (0.26)
H ₂	0.39 (0.08)	0.50 (0.05)	3.99 (0.07)	7.56 (1.65)	2.83 (0.45)	6.00 (0.28)
LS	0.236	0.137	0.326	0.069	0.077	0.766
SE	0.060	0.068	0.097	0.927	0.380	0.142
<i>Day 10th of lactation</i>						
C	0.66 (0.15)	1.07 (0.21)	3.37 (0.15)	8.42 (4.07)	2.70 (2.16)	5.86 (0.26)
H ₁	0.37 (0.04)	0.76 (0.08)	3.81 (0.27)	8.59 (1.86)	3.03 (1.00)	5.90 (0.34)
H ₂	0.49 (0.13)	0.72 (0.18)	3.81 (0.13)	8.07 (1.43)	2.71 (0.82)	5.30 (0.11)
LS	0.386	0.616	0.500	0.274	0.287	0.540
SE	0.064	0.091	0.125	1.398	0.773	0.159

() - numbers in brackets indicate SE for groups; NEFA - nonesterified fatty acids; BHBA- β hydroxybutyric acid

DISCUSSION

The beneficial effect of higher energy and protein feeding levels one week before and one week after calving in heifers of groups H₁ and H₂ on total nutrient balance was evident both in late pregnancy and during the entire lactation. This is indicated by the lower concentration of NEFA and BHBA and slightly greater serum concentration of glucose than in the control group (Vandelaar et al., 1999; Holcomb et al., 2001). The slightly higher serum albumin concentration in heifers given additional concentrates than in the control group suggests a greater supply of amino acids to the mammary gland (Whithaker et al., 1996). Changes in the concentration of these metabolites found in blood serum of heifers receiving supplemental concentrate suggest that the energy deficit was reduced after calving, as reflected in greater milk yield of the cows as a result of earlier and more persistent maximum production at the peak of lactation.

CONCLUSIONS

Increasing the energy and protein value of diets for heifers fed during the final week before calving and the first week of lactation, improves the blood metabolite profile and has a beneficial effect on milk yield, as indicated by the improved energy and protein balance of periparturient cows and lower susceptibility of heifers to metabolic disorders.

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STRESZCZENIE

Zwiększona ilość paszy treściwej dla jałówek w okresie okoloporodowym poprawia wydajność mleczną i profil metabolitów w krwi

Doświadczenie przeprowadzono na 28 jałówkach rasy czarno-białej (3 grupy po 8-10) w okresie od 3 tygodni przed planowanym wycieleniem do 300 dnia laktacji. W ostatnim tygodniu przed wycieleniem i w pierwszym tygodniu laktacji w grupie kontrolnej zwierzęta żywiono według norm IZ-INRA (2001), zakładając wydajność 30 kg mleka/d w szczycie laktacji. Dzielne dawki dla zwierząt grupy kontrolnej (3 kg/d paszy treściwej) wzbogacono w tym okresie dodatkiem 1 lub 2 kg/d paszy treściwej odpowiednio dla grup doświadczalnych H₁ i H₂. Przy zwiększonej dawce paszy treściwej stężenie nie estryfikowanych kwasów tłuszczowych i kwasu β-hydroksymasłowego w surowicy krwi było niższe, a stężenie glukozy w krwi i wydajność mleka wyższe niż w grupie kontrolnej.