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Short communication

Feeding conjugated linoleic acids and various concentrate proportions to late pregnant cows and its consequence on blood metabolites of calves

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ABSTRACT

The study aimed to investigate the influence of maternal conjugated linoleic acid (CLA) supplementation and various concentrate proportions in diets during late pregnancy on blood metabolites of unsuckled compared to suckled calves to examine possible CLA effects on calf metabolism. Pregnant German Holstein cows had *ad libitum* access to silage-based rations three weeks prior to calving. Cows received 100 g/d control fat (CON) or CLA supplement, either in a low (20%; CON-20, CLA-20) or high (60%; CON-60, CLA-60) concentrate diet. In total 5–6 calves were used out of potentially available calves per group to carry out the study. Blood samples were obtained from unsuckled calves immediately after parturition and from the same calves after staying for 16–24 h with their dam. Calves had *ad libitum* access to colostrum in this time. A*ntepartum* dry matter intake of dams of group CLA-60 was highest, whereas birth weight of calves remained unaffected. Nearly all blood metabolites were increased in suckled calves compared to unsuckled calves due to colostrum intake, whereas concentrations of non-esterified fatty acids decreased slightly and serum albumin showed similar concentrations after colostrum intake. However, no significant maternal diet effect and no effect by intake of CLA enriched colostrum could be observed. Results indicate that CLA supplementation and various concentrate levels in dairy cow diets during the final weeks of pregnancy did not affect the metabolic status of the offspring.

1. Introduction

Conjugated linoleic acids (CLA) are a group of positional and geometric isomers of linoleic acid characterized by conjugated double bonds. It has been reported that CLA exerts several physiological effects, like anticarcinogenic, antiatherogenic and immunomodulatory effects or growth and lean body mass promotion (reviewed by Tanaka (2005)). Especially, *trans*-10,*cis*-12 CLA isomer is frequently added to dairy cow diets because of its milk fat reducing properties (Baumgard et al., 2000). However, the mode of action of maternal CLA supplementation on their offspring has been scarcely investigated. The bovine fetus grows about 75% during the last two month of pregnancy, whereby fetal development and growth rate depend on maternal nutrition (Funston et al., 2010). Previous studies demonstrated that CLA fed to pregnant humans or rats were transferred from maternal to fetal blood and hence may affect metabolic functions of fetuses (Müller et al., 2007; Ringseis et al., 2004). Additionally, Dänicke et al. (2012) observed an altered fatty acid profile of erythrocyte lipids in calves after feeding CLA to early pregnant cows and

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suggested long-term effects of CLA on cows and their offspring. Moreover, preceding studies showed that *trans*-10, *cis*-12 CLA was consistently transferred into milk fat and that its proportion in milk fat increased dose-dependently during treatment period (Moore et al., 2004; Pappritz et al., 2011). Hence, colostrum from cows fed CLA could also have important implications on calves.

An experiment with dairy cows during transition period was used to study possible CLA impacts on metabolism of newborn calves. The experiment was previously described by Petzold et al. (2013) and for present investigation a part of the calves of the four experimental groups were used. The objective of this trial was to examine the effects of maternal CLA supplementation in a low or high concentrate diet during late pregnancy on blood parameters of unsuckled compared to suckled calves to elucidate whether an intrauterine exposure to CLA or the intake of CLA enriched colostrum affects calf metabolism. Compared to an adapted feeding, the impact of a high concentrate diet during late pregnancy on calf metabolism should be investigated due to the fact that maternal nutrition plays an important role in pre- and postnatal calf development, nutrition and metabolism (Funston et al., 2010). It was supposed that the level of energy intake of late pregnant cows could affect calf metabolism.

2. Material and methods

2.1. Experimental design, animals, feeding

The study was performed at the Experimental Station of the Institute of Animal Nutrition, Friedrich–Loeffler-Institute (FLI) in Braunschweig, Germany, according to European Community regulations concerning the protection of experimental animals. The present trial was part of a more comprehensive feeding study (Petzold et al., 2013). 64 pregnant German Holstein cows were assigned to one of four dietary treatments. 21 days prior to calving, group CON-20 ($n=16$) and CLA-20 ($n=16$) received 100 g/d control fat (CON) or CLA supplement in a low (20%) concentrate diet, whereas group CON-60 ($n=16$) and CLA-60 ($n=16$) were fed 100 g/d CON or CLA supplement in a high (60%) concentrate diet.

Cows had *ad libitum* access to partial mixed rations (PMR) consisting of 20% or 60% concentrate and 80% or 40% roughage (60% corn silage and 40% grass silage on dry matter [DM]-basis), respectively. PMR were offered in self-feeding stations (type RIC, manufacturer Insentec, B.V., Marknesse, the Netherlands). The fat supplements were included into 2 kg concentrate supplied via computerized concentrate feeding station (manufacturer Insentec, B.V., Marknesse, the Netherlands). The composition of concentrates and PMR are presented in Table 1. A commercial rumen-protected CLA preparation (Lutrell® Pure, BASF SE, Ludwigshafen, Germany), containing 10% *trans*-10, *cis*-12 CLA and 10% *cis*-9, *trans*-11 CLA, and a rumen-protected control fat preparation (Silafat®, BASF SE, Ludwigshafen, Germany), containing stearic acid instead of conjugated linoleic acids, were used as CLA and CON fat supplements, respectively. *Postpartum* (p.p.), cows were fed a PMR for *ad libitum* consumption based on 50% concentrate and 50% roughage (60% corn silage and 40% grass silage on DM-basis) while fat supplementation continued. All diets were formulated to meet the nutritional requirements of cows stated by the Society of Nutrition Physiology (GfE, 2001). Cows had *ad libitum* access to water.

In total only 5–6 calves were used out of 16 potentially available calves per group due to sampling only those calves where parturition was under personal control of staff and further through equal distribution of gender and pluri- and primiparous dams. Calves spent approximately 16–24 h p.p. with their mothers. In this time, calves had *ad libitum* access to colostrum of their corresponding dams. Calves were observed to consume colostrum within the first hour of life.

2.2. Sample collection and analyses

Each cow was equipped with an ear transponder to record daily individual feed and water intake. Representative PMR samples were taken daily, samples of concentrates were collected once, samples of corn and grass silage were taken twice a week and pooled monthly. The chemical composition of the feed was analyzed according to methods of VDLUFA (Naumann and Bassler, 1997). *Postpartum*, cows were milked twice daily. Live weight was recorded once a.p. and automatically daily p.p..

Blood samples were obtained from each of the confined unsuckled calves from *Vena jugularis externa* immediately after parturition. The second blood samples were drawn from calves after staying approximately 16–24 h with their mother. In this time, calves had *ad libitum* access to colostrum. Hence, amounts of colostrum intake between these blood samples could not be recorded. Blood was centrifuged at 2000 × g and 15 °C for 15 min after incubating 30 min by 30 °C. Concentrations of albumin, aspartate amino-tranferase (ASAT), β-hydroxybutyrate (BHB), γ-glutamyl-transferase (GGT), glutamate dehydrogenase (GLDH), glucose, non-esterified fatty acids (NEFA), total bilirubin, total cholesterol and total protein in blood serum of calves were determined photometrically by an automatic clinical chemistry analyzer (Eurolyser, Qinlab Diagnostic GbR, Martinsried, Germany). Birth weight (BW) of calves was determined after separating from their dams.

2.3. Statistical analyses

The software package SAS (Version 9.2, SAS Institute, Cary, NC, USA) was used for all statistical evaluation. Blood serum data were processed using the PROC MIXED procedure containing dietary treatment of dams during late pregnancy (split up into concentrate feeding, CLA supplementation and the concentrate × CLA interaction), time of sampling (before and after colostrum intake) and their interactions as fixed factors. Because of repeated measurements during experiment, individual animal effects were considered by using REPEATED procedure. BW were analyzed by using analysis of variance (ANOVA) according to a two factorial design, considering sex of calves, respective diet of their dam (CON-20, CON-60, CLA-20, CLA-60) and their interactions as fixed factors. DMI, PMR and concentrate intake of cows was processed using a random-regressions