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Relationships between milk fatty acids composition in early lactation and subsequent reproductive performance in Czech Fleckvieh cows

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ABSTRACT

Increase of milk yield after calving causes changes in milk fatty acids (FA) composition and simultaneously corresponds with reproduction performance decrease. The objective of this study was to evaluate the relationships between milk FA group composition (SFA, saturated fatty acids; MUFA, monounsaturated fatty acids; and PUFA, polyunsaturated fatty acids) during the first 5 lactation weeks and subsequent reproductive results (INT, calving to first service interval; NUM, number of services per conception, and DO, days open) in Czech Fleckvieh cows. A total of 1231 individual milk samples from 382 cows were collected and subsequently analyzed. Simultaneously, body condition score (BCS) was weekly evaluated as well. Software SAS 9.1 was used for statistical analysis. Daily milk yields increased whereas BCS, milk fat and protein contents decreased during period observed. The reduction of basic milk components (% of fat, % of protein) was associated with increased SFA and decreased MUFA, respectively PUFA contents. Significant ($P < 0.01$–0.05 days) increase in NUM (+0.15 to +0.29 AI dose) and DO (+8.16 to 15.44 days) were detected in cows with the lowest SFA content. On the contrary, cows with the highest content of MUFA presented significantly ($P < 0.01$–0.05) higher values of NUM (+0.13 to +0.30) and DO (+7.26 to +15.35 days). Milk FA groups composition in early lactation potentially used as NEB indicators, especially SFA and MUFA proportion, affected subsequent reproductive results of Czech Fleckvieh cows. Therefore, its post-partum values could serve as predictors of potential fertility of dairy cows.

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1. Introduction

Peripartal period is the most important in herd management (Adamski et al., 2011; Lane et al., 2013). The biggest changes in intensity of dairy cows' metabolism are reflected mainly in the first part of lactation (Ducháček et al., 2012). This period is characterised by the reduction of feed intake, insufficient for maintenance requirements, milk production, and reproductive performance (Reist et al., 2000). As a result, cows enter the stage of negative energy balance (NEB) (Walsh et al., 2011). According to Rossi et al. (2008), the depth and duration of NEB is the main factor influencing the decline of reproductive efficiency in high-yielding dairy cows. The influence of NEB on reproductive parameters was documented in a number of studies, however mainly in Holstein cows only (Wathes et al., 2007; Tamadon et al., 2011; Esposito et al., 2014).

The utilization of energy reserves is reflected in the content of milk fat (F) (Bauman et al., 2006), respectively in fatty acids (FA) composition and mutual ratio between

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individual FA groups proportion in milk (Ducháček et al., 2014). These FA proportions are represented by saturated (SFA) (above 73%), unsaturated (UFA) (above 26%), from that monounsaturated (MUFA) (above 23%), polyunsaturated (PUFA) (above 3%) and other groups of FA as is volatile (VFA) or branched (BFA) (Pešek et al., 2006; Stoop et al., 2009; Stádník et al., 2013; Ducháček et al., 2013). The composition of these FA groups in milk depends on breed, lactation stage, depth of NEB, individuality, and other factors (Kaylegian and Lindsay, 1995; Hanuš et al., 2010). Fatty acids are hormones precursors important for metabolism and reproduction (Gulliver et al., 2012), for example prostaglandins (Petit et al., 2001). Bastin et al. (2011a) confirmed the relationships between FA groups and reproduction, respectively days open length in Holstein cattle.

Milk F varies throughout lactation and is affected by many factors (Petit et al., 2001), energy status among them (Čejna and Chládek, 2005). Milk F and FA are also easily and widely determined milk characteristics in practice. Studies by Berry et al. (2006), Soyeurt et al. (2006), and Bastin et al. (2011b) detected fatty acid composition in milk for predicting energy status and also fertility in Holstein dairy cows using MIR (mid infrared). Also, we can hypothesis that FA groups composition during the first lactation period influence reproductive parameters of Czech dual-purpos cattle breed. Therefore, the objective of the study was to evaluate the effect of milk FA group composition in milk during the first 5-week post partum on subsequent reproductive traits in Czech Fleckvieh cows.

2. Material and methods

2.1. Animals

A total of 382 Czech Fleckvieh cows from a single farm were included in the analysis (103, 113, 84, 83 cows in the 1st, 2nd, 3rd, and 4th and subsequent lactations, respectively). Milk samples ($n = 1231$) were collected weekly during the first 5 weeks of lactation. Lower number of milk samples was caused by practical conditions as mastitis incidences and precocious transfer of cows to other production groups/stable with different feeding ratio composition. The BCS of cows was determined in accordance with the methodology for Czech Fleckvieh dairy cows (Hanuš et al., 2004; Kučera, 2009) by the only one technician weekly as well. A body condition index (a 5-point scale with 0.25 point increments) was used to evaluate BCS level. The cows calved within the period of 6 months, from October to March. The cows were loose housed in a cubicle straw-bedded barn and fed a total mixed ratio (TMR). The ingredient composition of the diet corresponded to the level of daily milk yields (MY). Thus the TMR was same for all the animals through the entire period (5 weeks of lactation). Therefore the detailed proportion of FA content in TMR was not objective of this study. TMR was consisted of maize and alfalfa silage (51%), grass and alfalfa hay (20%), brewery draff (6%), bakery waste (5.95%), molasses commercial concentrates (7%), barley (10%) and mineral supplements (0.05%).

2.2. Collection of samples and analyses

Two aliquot milk samples from each cow were collected in accordance with the official methodology of the milk performance recording system (ICAR, 2012). The first sample with a preservative was heated to $39 \pm 1\,^{\circ}C$ and used to determine basic milk components (% of fat, % of protein) using Milkoscan 133B (N. Foss Electric; Denmark). The second sample without a preservative was used for the extraction of F and determination of FA composition. Standard method for F extraction in accordance with ČSN EN ISO 1211 (570534) was applied. The extract was obtained using a water-based-solution of ammonia, ethanol, diethylether and petrolether. FA methyl esters were prepared by the potassium hydroxide catalysed methylation and extracted into heptane. Gas chromatography (GC) of FA methyl esters was performed using the Master GC (DANI Instruments S.p.A.; Italy) (split regime, FID detector) on a column with polyethylene glycol stationary phase (FameWax – 30 mm × 0.32 mm × 0.25 μm). Helium was used as the carrier gas at a flow rate of 5 ml/min. The temperature programme used for GC was as follows: 50 °C (2 min), after which the temperature was increased to 230 °C at 10 °C/min (8 min), the temperature of the detector being 220 °C. Content ($mg.100\,g^{-1}$) and proportion (%) of 34 individual FA subsequently divided to FA groups (SFA, MUFA, PUFA) were determined from individual milk samples.

Data characterizing cowsí reproductive performance (INT, calving to first service interval; NUM, number of services per conception; and DO, days open) were obtained from the farm records software. Cows were examined sonographically between 60 and 74 days after parturition. Cows with corpus luteum detected on ovary were subsequently inseminated at natural heat. If sonographic examination detected luteal or follicular cysts, the cow was included to OVSYNCH program as biotechnology generally applied in dairy farms (Alkar et al., 2011).

2.3. Data handling and statistical analysis

The data were analysed with statistical software SAS 9.1 (SAS/STAT® 9.1. 2004). The procedures MEANS and UNIVARIATE were used to calculate basic statistics. The REG procedure (STEPWISE option) was used to develop a model including effects of parity, FA group, and regression on days in milk for the evaluation of reproductive parameters in Czech Fleckvieh cows. The normal distribution of dataset was expected according to Salkind and Rasmussen (2007). To obtain balanced data, cows were divided into four classes for parity (1st – $n = 103$, 2nd – $n = 113$, 3rd – $n = 84$, and 4th and subsequent lactations – $n = 83$). FA groups were divided into three classes. Limit criteria were determined as the mean ± standard deviation ($<\bar{x} - 1/2\,s$; $\bar{x} - 1/2\,s$ to $\bar{x} + 1/2\,s$; $>\bar{x} + 1/2\,s$) from the basic statistics of the whole set of samples collected during 5 weeks of observation due to obtaining balanced groups analysed. Each individual sample of milk was subsequently allocated to one of three groups according to limit values stated. The distribution of milk samples to groups

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