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Bovine colostrum: Changes in lipid constituents in the first 5 days after parturition

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ABSTRACT

Despite the great interest paid to protein components in colostrum, fat also plays an important role in the supply of essential nutrients to provide energy, increase metabolism, and protect the newborn calf against microbial infections. This work aimed to elucidate levels of different fat components in colostrum, in particular fatty acid (FA), triglyceride (TG), cholesterol, and phospholipid contents. Colostrum samples from primiparous and multiparous (3–5 lactations) Holstein dams, fed the same ration indoors, were collected on the first 5 d after parturition, analyzed, and compared with milk samples from the same cows collected at 5 mo of lactation. Fat content during the first 5 d of milking did not vary. However, the proportion of short-chain saturated FA increased and that of long-chain FA decreased. The concentration of n-3 FA was higher on the first day of calving than on the other days, with clear differences in the number and type of n-3 FA. Conjugated linoleic isomers and *trans* FA slowly increased from d 1 to 5, reaching a maximum at 5 mo of lactation. Changes in the distribution profile of TG were observed as lactation progressed, with a shift from a prevalence of high-carbon-number TG (C48–50) on d 1 to a bimodal distribution (maxima at C38 and C50) on d 5, characteristic of mid-lactation milk. Cholesterol content was high in the first hours after calving and rapidly decreased within 48 h. Colostrum sampled on d 1 also had a high content of phospholipids. Phosphatidylethanolamine and sphingomyelin were, respectively, lower and higher in the first 5 d than in mid-lactation milk. The influence of lactation number on colostrum fat composition was also considered and significant results were obtained for all FA groups (except for polyunsaturated and n-6 FA) and TG content.

Key words: fatty acid, cholesterol, phospholipid, bovine colostrum

INTRODUCTION

Interest in the composition of cow colostrum is usually focused on protein content; in particular, on immunoglobulins and immune factors through which calves acquire passive immunity to prevent disease and mortality (Quigley and Drewry, 1998; Weaver et al., 2000; Stelwagen et al., 2009). In addition to immunological protection immediately after birth, colostrum supplies the neonatal calf with high quality nutrients, including vitamins (especially A, D, and E) and minerals, of which it has low reserves (Ontsouka et al., 2003; Kehoe et al., 2007).

One of the least considered colostrum components is fat, which plays a major role in the supply of constituents to neonatal calves: it provides energy for heat production to maintain body temperature (thermogenesis), and FA oxidation is useful to continue active gluconeogenesis to keep glucose homeostasis (Hammon et al., 2012). Moreover, some FA are beneficial not only for their nutritional properties, but also for specific health effects (Hill et al., 2011). In addition, some digestion products of bovine milk triglycerides (**TG**) and membrane lipids appear to be effective for their antimicrobial action (Sprong et al., 2001, 2002; Desbois and Smith, 2010).

In studies on colostrum fat, the main attention has been focused on its total content during the first days after calving. Only a few and often dated references deal with the different classes of lipid constituents (Stull et al., 1966; Nardone et al., 1997; Leiber et al., 2011). Specific interest in some acids such as *trans* isomers, CLA, and branched-chain FA has been shown by other authors (Attaie et al., 1993; Paszczyk et al., 2005).

To our knowledge, only 2 studies have focused on the TG composition of colostrum. A first attempt was done by Parodi (1983), who studied the positional distribution of FA in TG in prepartum secretion and early postpartum milk. Laakso et al. (1996) studied the changes in TG composition of colostrum fat of 3 cows during the first week after parturition.

The phospholipid (**PL**) content and composition within lactations, including d 3 and 7 after parturition,

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were investigated by Bitman and Wood (1990). Phospholipids are mainly located on the milk fat globule membrane, surrounding the fat globules. Glycerophospholipids and sphingolipids are quantitatively the most important PL in milk and comprise a class of biological molecules that play structural and functional roles. Moreover, considerable evidence exists that PL have several beneficial health effects (Contarini and Povolo, 2013), such as the protection against gastrointestinal infections, that is exerted particularly by sphingomyelin (Sprong et al., 2002).

Considering the importance of colostrum for calf nutrition, the composition and quality of its fat fraction cannot be ignored and needs to be updated. The aim of this study was to determine the evolution of the lipid fraction of bovine colostrum of Holstein dams in the first 5 d after calving compared with milk at 5 mo of lactation. The main lipid constituents, in particular FA, TG, cholesterol, and PL, were analyzed to evaluate the influence of days from birth and lactation number on colostrum fat composition.

MATERIALS AND METHODS

Sampling

Milk and colostrum were sampled from Holstein cows belonging to the dairy herd of Centro di Ricerca per le Produzioni Foraggere e Lattiero-Casearie (CRA-FLC, Lodi, Italy). The experimental group consisted of 10 dams, 5 primiparous (**P**) and 5 multiparous (**M**; 3–5 lactations), fed indoors. During the dry period, cows were fed, ad libitum, diets based on hay with the addition of 1 kg of complementary feed (CP 24.0%; crude oils and fats 3.6%; crude fiber 7.9%; crude ash 7.6%; sodium 1.16%; magnesium 0.70%), which was increased to 3 kg in the last 10 d before calving. Immediately after parturition and throughout the lactation period, cows were supplied with a TMR. The daily feed ration consisted of (DM basis) 30% corn silage, 22% hay, and 40% concentrate, with mineral and vitamin supplements. Each cow received 22 kg (DM). Diet composition on DM basis was 15.5% CP, 4.5% crude fat, 17% ADF, and 30% NDF. The proportion of FA in TMR fat was C14 = 1.1%, C16 = 12.7%, C18 = 4.0%, C18:1 = 25.5%, C18:2 = 50.8%, and C18:3 = 4.6%. Samples of colostrum were taken from the afternoon milking on the day of calving and once a day for the following 4 d, always at the same time. Milk of the same cows was also sampled at 5 mo after calving. Samples (1 L) were divided into aliquots: one part was refrigerated for chemical composition analysis within 24 h and the rest was frozen at −20°C immediately after collection and gently thawed at 37°C when required for lipid analysis.

Chemical Composition

Colostrum and milk samples were analyzed with MilkoScan FT2 (Foss, Padova, Italy) for the determination of protein, fat, and lactose contents, using a specific calibration for milk of the same species, according to Romero et al. (2013). Spectra were acquired in the range from 926 to 5,000 cm^{-1}, using a pathlength of 45 μm at a constant temperature of 40 ± 1°C. To work within the range of protein calibration, 24-h samples were diluted 1:5 (wt/wt) and 48- to 120-h samples were diluted 1:2 (wt/wt), following the same procedure as in Vetter et al. (2013). Results were expressed as grams per 100 grams of milk.

Fat Extraction

Total lipids were extracted from colostrum and milk by homogenization with chloroform:methanol (2:1, vol/vol) according to Folch et al. (1957). The extract was shaken and equilibrated with one-fifth its volume of a saline solution (0.05 *N* of NaCl). The solvent phase was separated, filtered, and evaporated under vacuum.

Triglycerides Composition and Cholesterol Content

Triglyceride composition, together with cholesterol, was determined according to the Official EC method (European Commission, 2008). The analysis was performed on a Hewlett Packard 5890 gas chromatograph (Agilent, Palo Alto, CA). An Easy 1 (Agilent Technologies) capillary column (4 m long, 0.32 mm i.d., 0.1 μm film thickness) and a flame-ionization detector at 350°C were used. Fat samples were dissolved in hexane at a concentration of 3 mg/mL. On-column injection (1 μL) was adopted and hydrogen was used as carrier gas at a flow rate of 5 mL/min. Oven temperature was held at 60°C for 2 min, programmed to 340°C at a rate of 35°C/min, held at 340°C for 5 min. Calibration, as required by the Official EC method, was performed by analyzing Certified Reference Material 519 (European Commission, 1997). Triglycerides were identified on the basis of the total number of carbon atoms, excluding glycerol, according to the Official EC method (European Commission, 2008). Results are expressed as mass fraction (%).

Fatty Acid Composition

Fatty acids were analyzed and identified according to Povolo et al. (2012) and expressed as grams per 100 grams of FAME. Fatty acids were grouped in different classes. Saturated FA from 4 to 24 carbon atoms, including branched- and odd-chain FA were considered as