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Partial suckling of lambs reduced the linoleic and conjugated linoleic acid contents of marketable milk in Chios ewes

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ABSTRACT

The objective of this work was to investigate the effect of weaning systems applied in a commercial dairy sheep farm on the fatty acid (FA) composition of marketable milk produced. Forty second parity, purebred Chios ewes were allocated to the following weaning treatments: (a) ewes were weaned from their lambs at 48 h after birth and machine milked twice daily [no lambs (NL) group, n = 20]; or, (b) starting 48 h postpartum, ewes were separated from their lambs for 12 h during the evening, machine milked once daily the following morning, and lambs were allowed to suckle for 12 h during the day for the first 5 wk of lactation [partial suckling (PS) group, n = 20]. After weaning of the PS lambs at wk 6 of age, all ewes were machine milked twice daily. Commercial milk yield and milk composition was recorded weekly (fat, protein, FA content) or fortnightly (somatic cell counts) throughout the first 10 wk of lactation. The PS ewes compared with NL group produced commercial milk lower in milk yield, milk fat, and somatic cell counts, but not in protein content during the first 5-wk period. Such differences were not observed after weaning of the PS lambs. The FA profile of commercial milk was also affected by partial suckling during the preweaning period. Total polyunsaturated FA were higher in NL compared with PS ewe milk at wk 1, 2, 4, and 5 (on average, 21% higher), whereas no differences were detected between NL and PS ewe milk from wk 6 to 10 of lactation. From the polyunsaturated FA, linoleic acid (C18:2 *cis*-9,*cis*-12) and conjugated linoleic acid (C18:2 *cis*-9,*trans*-11; rumenic acid) were particularly affected, showing on average a reduction of 18 and 38%, respectively. From the monounsaturated FA, vaccenic acid (C18:1 *trans*-11) was affected during wk 1 and 2 of the treatment period, with the PS ewe milk having reduced content compared with the NL milk. Other unsaturated FA, such as oleic acid and α-linolenic acid, or saturated FA were not found to be affected by the weaning treatment. The results indicate that partial suckling of lambs during the first 5 wk of lactation adversely affected both the total fat content of milk obtained by machine milking of their dams and the unsaturation content of the milk fat. Particularly affected were the linoleic acid and *cis*-9,*trans*-11 conjugated linoleic acid content of ewe milk.

Key words: weaning, polyunsaturated fatty acid, sheep, rumenic acid

INTRODUCTION

Dairy products made from ovine milk are economically important in many Mediterranean countries (Boyazoglu and Morand-Fehr, 2001). Knowledge of the FA composition of sheep milk, which is rich in fat, is important for reasons related to human health. Although controversial (Siri-Tarino et al., 2010) the consumption of SFA has been linked to increased risk of cardiovascular disease, whereas the consumption of other lipids, such as CLA (C18:2 *cis*-9,*trans*-11; rumenic acid), vaccenic acid (C18:1 *trans-11*), or total PUFA, has been considered as contributing to the prevention of atherosclerosis, osteoporosis, or cancer (WHO/FAO, 2002; Huth et al., 2006). As a result, research during the last decade has focused on the variation of FA content in ruminant milk due to nutrition (Sterk et al., 2012), genetics (Stoop et al., 2008), or management practices such as organic and low-input farming (Butler et al., 2008, 2011), whereas other management practices have attracted little attention. A management practice known to affect fat content of commercial milk produced by ruminants is the partial suckling of the offspring reported both in sheep (Papachristoforou, 1990; Fuertes et al., 1998; McKusick et al., 2001) and cows (Bar-Peled et al., 1995; Cozma et al., 2013).

Partial suckling systems, although not common in dairy cattle, are extensively applied in dairy sheep in many parts of the world, usually during the first 4 to 6 wk of lactation. The application of partial suckling in sheep is a means of increasing marketable milk yield compared with continuous suckling, as the amount of milk produced during the suckling period represents approximately 30% of the total ewe milk production (Folman et al., 1966; Louca, 1972; Lawlor et al., 1974).

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Several partial suckling systems have been investigated in relation to their effects on milk yield and lamb growth (Folman et al., 1966; Papachristoforou, 1990; McKusick et al., 2001), and evidence exists to support their economic superiority as compared with a traditional system of continuous lamb suckling until weaning or a more intensive system where lambs are separated from their dams immediately after birth and artificially reared on milk replacer (McKusick et al., 2001). However, the main disadvantage of partial suckling systems is the lower fat percentage (approximately 20% reduction) of marketable milk obtained from ewes during the partial suckling period, which has a significant effect on both price and dairy processing characteristics of sheep milk (Marnet and Komara, 2008; Jaeggi et al., 2008).

The FA profile of commercial ovine milk obtained during partial suckling has not been previously studied and the variation of different FA (i.e., SFA, PUFA, or essential FA) in marketable ewe milk during this early lactation period is largely unknown. Earlier studies have reported the ability of the suckling ewe to withhold a certain amount of milk and milk fat within the udder (alveolar milk) during machine milking and release it in subsequent suckling by the lambs (Papachristoforou, 1990). More recently, McKusick et al. (2002) investigated the composition of alveolar and cisternal milk fractions of East Friesian dairy ewes under partial suckling and provided evidence of an inhibition of milk fat transfer from the alveoli to the cistern of the ewe udder during machine milking, whereas other milk components were unaffected. McKusick et al. (2002) also reported a tendency for a specific FA, octadecenoic acid (sum of C18:1 isomers), to be higher in the alveolar fraction of milk compared with the cisternal fraction, suggesting a different distribution of individual FA within the udder when partial suckling was applied. Furthermore, a recent study of Cozma et al. (2013), investigating the effects of the calf presence or suckling during early lactation in different cattle breeds, reported an effect on FA content of milk produced during treatment. Those authors indicated that calf presence or suckling during cow milking significantly reduced C18:0, C18:2 n-6, C18:3 n-3, and total PUFA percentage in milk fat. To the best of our knowledge, similar research has not been conducted in dairy sheep.

The objectives of the present study were to determine (a) the effect of partial suckling of lambs on FA content of marketable milk obtained by their dams during machine milking, and (b) any carry-over effect of this management practice on FA content of ewe milk after weaning of lambs. These effects were studied during the first 10 wk of lactation, when most changes in milk FA content are likely to occur (Bauman and Griinari, 2003). Along with these objectives, the effect of weaning system on other production traits such as milk yield, composition, and quality (SCC) were also investigated.

MATERIALS AND METHODS

Experimental Design

Forty second-parity, purebred Chios ewes were selected from a commercial farm according to stage of pregnancy, age, and live weight and were used in the present experiment during the winter of 2012 to 2013. The animals were randomly allocated to 2 homogeneous subgroups which were balanced for the number of offspring and the live weights of ewes after parturition (average: 1.8 lambs per ewe, live weight ± SEM of ewes: 58.2 ± 0.6). The 2 groups were assigned to 2 different weaning systems. (1) Ewes were weaned from their lambs at 48 h postpartum and machine milked twice daily, and their lambs reared artificially on milk replacer [no lambs (**NL**) group, n = 20]. (2) Beginning 48 h postpartum, ewes were separated from their lambs for 12 h during the evening (from 1930 to 0730 h), machine milked once daily the following morning, and their lambs were allowed to suckle for 12 h during the day [partial suckling (**PS**) group, n = 20]. Lambs of the PS group were kept in nearby pens during the night, allowing for audio and olfactory but not visual contact with their dams. At the end of wk 5, lambs from the PS group were weaned and ewes were subsequently machine milked twice daily for the rest of the study.

All animals from both treatments were housed indoors in adjacent pens and were group fed the same TMR diet to 1.1 times their maintenance energy (0.401 MJ/kg of weight$^{0.73}$) and milk production requirements [dietary ME (MJ/kg of milk): Y = (1.94 + 0.43X)/0.62, where X is the fat percentage and 0.62 the efficiency of utilization of dietary ME for milk production of Chios ewes; Economides, 1986]. The ewe diet consisted of cereal straw and a concentrate ration of barley grain, whole corn, sugar beet pulp, soybean meal, along with vitamin trace element mixture (DSM Nutritional Products, Ayrshire, UK) to meet the requirements of the lactating ewes (NRC, 2007). Concentrate chemical composition was 907 g of DM/kg, 954 g of OM/kg of DM, 22 g of ether extract/kg of DM, 155 g of CP/kg of DM, 238 g of NDF/kg of DM, and 166 g of ADF/kg of DM, measured according to standard ISO methods [ISO, 1999b, 2002a, 1999a, 2009, 2006, and 2008 for moisture, ash, ether extract, CP, NDF and ADF, respectively). The feed was offered thrice (0600, 1200, and 1600 h) daily. Animal weights were recorded fortnightly throughout the experiment.