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Changes in milk composition as affected by subclinical mastitis in sheep and goats

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Abstract

The present study focused on gaining a better insight into how subclinical mastitis at the gland level in dairy sheep and goats affects milk yield and compositional changes in relation to curd yield. Animals chosen for the study had one udder half infected with identified coagulase-negative staphyloccocci (CNS) species and the contra-lateral gland was free of bacteria. Udder halves were tested for udder bacterial condition, California mastitis test, somatic cell count (SCC), milk yield, milk composition (fat, protein, lactose, casein (CN), and whey protein), curd yield (Yc) and milk clotting time (Tc). Data were statistically analyzed with a nested block design. Curd yield from the infected halves was lower than that from the uninfected ones for both sheep and goats, although CN concentrations were almost equal in the two glands. The data suggest that knowledge of the gross CN content in the milk is insufficient for predicting Yc, probably because of modifications in the CN micelles or in the various casein micelle components that are more detrimental to curd formation than they are to the CN concentration itself. The primary enzymatic coagulation is based on the action of rennin on κ-casein, which thereafter exposes hydrophobic sites on the casein micelle, thus making it available for the secondary aggregation reaction. The complications in the coagulation process are also supported by the longer Tc of the milk from the infected glands. However, the effect of rennet on the caseins and thereafter the coagulation process may be impeded by only partial hydrolysis of κ-casein and more pronounced hydrolysis of the other caseins by enzymes such as PL and cathepsin.

Keywords: Sheep, goat, udder infection, milk yield
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Introduction

Udder infection in dairy sheep and goats has a major effect on reducing both yield and quality of milk, thus leading to greater economic losses than those reported for dairy cattle (Watson & Buswell, 1984). In an earlier study on 1000 sheep from 20 Israeli dairy flocks (Leitner *et al*., 2004a) and 500 goats from 10 Israeli dairy herds (Leitner *et al*., 2004b), it was found that milk yield of the uninfected udder halves was significantly higher whereas fat and total protein levels were lower compared with the infected ones. However, in that study a direct comparison between infected and uninfected glands was not possible because the measurements were based on animals rather than single-glands, with some animals having one infected and one healthy gland. The present study focused on how subclinical mastitis at the gland level in dairy sheep and goats affected milk yield and other compositional changes in relation to curd yield.

Materials and Methods

Animals chosen for the study had one udder half infected with identified coagulase-negative staphyloccocci (CNS) species while the contra-lateral gland was free of bacteria. Udder halves were tested for udder bacterial condition, California mastitis test, somatic cell count (SCC), milk yield, milk composition (fat, protein, lactose, casein (CN), and whey protein), curd yield (Yc) and milk clotting time (Tc). Data were statistically analyzed with a nested block design using SAS JMP (SAS, 2002).

Results

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Milk yield of the infected halves was lower ($P < 0.001$) than that of the uninfected halves in both sheep and goats (0.72 *vs*. 1.52 kg/day in sheep and 1.38 *vs*. 1.96 kg/day in goats) (Figure 1). In sheep, concentrations of fat, protein, lactose and casein in infected udder halves were significantly lower than those in the uninfected halves, whereas concentrations of total whey proteins and albumin were significantly higher (Table 1). In goats, only lactose concentration in the infected glands was lower ($P < 0.004$) than in the uninfected ones, while concentrations of fat, protein and casein did not differ between the uninfected and infected halves. Total whey protein and albumin concentrations were significantly higher in the infected than in the uninfected glands.

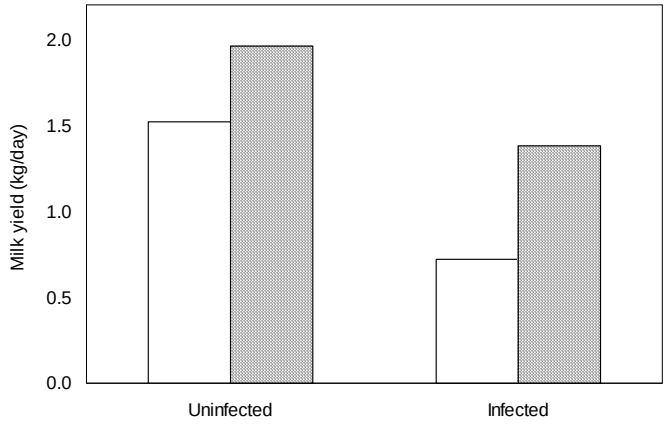

Figure 1 Milk yield (half) of sheep or goats where one udder half was infected with coagulase-negative staphyloccocci species while the contra-lateral was not infected

Table 1 Mean and s.e. of fat, protein, lactose, whey, casein and albumin concentrations in milk from uninfected *vs*. infected udder halves of sheep and goats

Parameter	Sheep		Goats	
	Uninfected	Infected	Uninfected	Infected
Fat (g/L)	64.9 ± 0.26	61.7 ± 0.21	38.9 ± 1.1	38.8 ± 1.2
Protein (g/L)	58.5 ± 0.07	53.5 ± 0.10	34.2 ± 0.5	35.0 ± 0.5
Lactose (g/L)	44.7 ± 0.08	33.5 ± 0.16	47.0 ± 1.0	41.7 ± 1.3
Whey (g/L)	11.9 ± 0.38	12.8 ± 0.16	6.1 ± 0.3	6.8 ± 0.4
Casein (mg/mL)	45.9 ± 1.36	40.5 ± 1.59	28.1 ± 0.7	28.2 ± 0.8
Albumin (µg/mL)	517 ± 31	759 ± 59	280 ± 22	472 ± 50

In sheep, curd yield from the infected glands was lower ($P < 0.0001$) than from the uninfected glands (Figure 2). This difference was mainly due to the lower quantity of milk produced by infected glands. The effect on sheep for this variable was significant ($P < 0.002$). Clotting time of milk from the infected halves (909 s) was longer ($P < 0.0001$) than milk from the uninfected halves (413 s) (Figure 2). In goats, Yc was lower ($P < 0.0001$) in the infected halves, with a significant effect on goats ($P < 0.0001$). The Tc was longer ($P < 0.02$) in milk from infected halves than from uninfected ones, with a tendency for an effect on goats ($P < 0.08$) (Figure 3).

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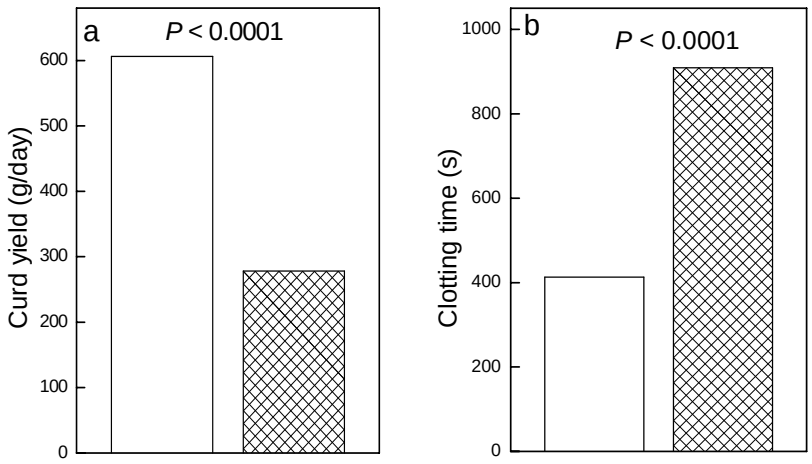
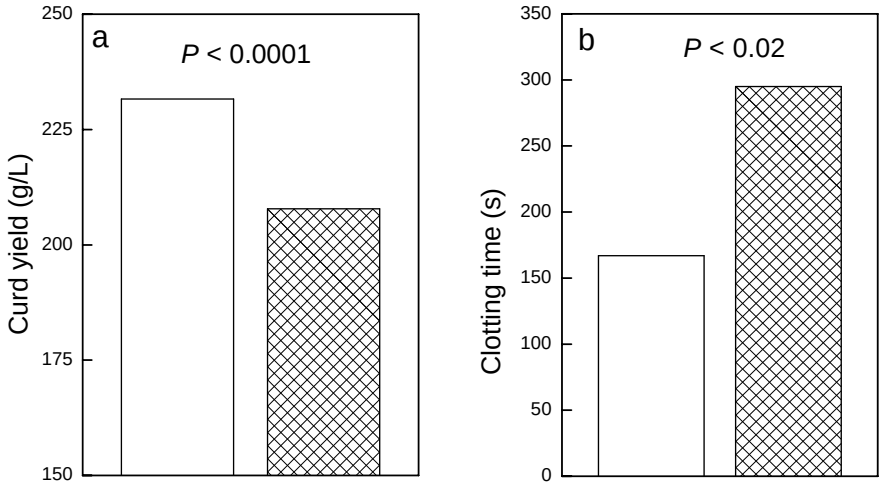


Open bars – uninfected; Hatched bars – infected

Figure 2 Effect of subclinical mastitis on curd yield (a) and clotting time (b) in milk of infected *vs.* uninfected udder halves of sheep

Discussion

In both sheep and goats some of the milk constituents are significantly influenced by the presence of intra-mammary infection. Milk of infected glands has a significantly lower concentration of lactose, which is accompanied by significantly higher whey and albumin concentrations. The accumulation of whey proteins probably results from a breakdown of the caseins and other milk proteins, which down-regulate milk secretion (Silanikove *et al.*, 2000; Shamay *et al*., 2003) and explain the lower lactose concentration.



Open bars – uninfected; Hatched bars – infected

Figure 3 Effect of subclinical mastitis on curd yield, Yc (a) and clotting time, Tc (b), in milk of infected *vs.* uninfected udder halves of goats

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Curd yield from the infected halves was lower than that from the uninfected ones for both sheep and goats, although CN concentrations were almost equal in the two glands. The data suggest that knowledge of the gross CN content in the milk is insufficient for predicting Yc, probably because of modifications in the CN micelles or in the various casein micelle components that are more detrimental to curd formation than they are to the CN concentration itself. The primary enzymatic coagulation is based on the action of rennin on κ-casein, which thereafter exposes hydrophobic sites on the casein micelle, thus making it available for the secondary aggregation reaction. The complications in the coagulation process are also supported by the longer Tc of the milk from the infected glands (Ernstrom & Wong, 1974). However, the effect of rennet on the caseins and thereafter the coagulation process may be impeded by only partial hydrolysis of κ-casein and more pronounced hydrolysis of the other caseins by enzymes such as PL and cathepsin.

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