Factors Affecting Ewe Somatic Cell Count and Its Relationship with Lamb Weaning Weight in Extensively Managed Flocks

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IMPACT STATEMENT

Clinical mastitis contributes to increased culling rates and lost revenue in Western sheep production, but the importance of subclinical mastitis is less clear. Results from this work suggest that subclinical mastitis is prevalent and has large economic consequences in the form of reduced lamb weaning weight. Strategic trace mineral supplementation and other management practices to reduce its prevalence warrants further investigation.

SUMMARY

The economic impact of mastitis in dairy species is well documented and efforts to reduce its prevalence through husbandry and genetic selection have been extensive. Females from non-dairy breeds are also prone to mastitis but since their udders are not regularly handled and their milk is not a commodity, its prevalence and impact are less clear. Milk was collected from healthy ewes at MSU and the U.S. Sheep Experiment Station (USSES) and somatic cell count was quantified and transformed to the $\log_{10}$ scale (LSCC). MSU milk was collected at approximately 5 (early) and 35 d (peak) after lambing, but only at peak lactation at USSES. Total litter weaning weight at 120 d (LWW) was analyzed separately for each flock. At MSU, early LSCC negatively affected LWW ($P < 0.01$). Peak LSCC reduced LWW at USSES ($P < 0.01$) but not at MSU ($P = 0.87$). On average, a unit increase in early or peak LSCC was associated with a 28.2 and 32.6 lb decrease in LWW at MSU and USSES, respectively. Ewes at MSU that maintained low LSCC (< 5.7) at both collections had greater ($P = 0.02$) serum Zn concentration (1.53 μg • mL^{-1}) than ewes with low LSCC in early and high LSCC (≥ 5.7) in peak lactation (1.13 μg • mL^{-1}). Overall, the percentage of ewes with high LSCC was 19 and 17% at MSU and USSES, respectively.

INTRODUCTION

Mastitis, an inflammation of the mammary gland caused by bacterial infection, is characterized by palpable lumps in the udder, abnormal milk, and tissue discoloration in its clinical state (Menzies and Ramanoon, 2001). The average incidence of clinical mastitis (CM) is relatively low (1.2 to 3%) across flocks sampled around the world (Quinlivan, 1968; Arsenault et al., 2008; Cooper et al., 2016), but can have large variation within flocks (0 – 37%; Grant et al., 2016). Nevertheless, CM was the primary reason for culling 6.7% of ewes in the U.S. in 2011 (USDA APHIS, 2011).

Subclinical mastitis (**SCM**) has no visual symptoms, but can be diagnosed through bacterial culture and/or quantifying somatic cell count (SCC) in milk. The morbidity rate of SCM in sheep is much greater than CM (12 – 50%; Watkins et al., 1991; Keisler et al., 1992). Lambs reared by ewes with experimentally (Fthenakis and Jones, 1990) and naturally acquired SCM (Moroni et al., 2007) have reduced growth. However, the direct effect of maternal SCC on lamb growth has been inconsistent (Ahmad et al., 1992) or insignificant (Gross et al., 1978; Keisler et al., 1992) in the reviewed literature. The objectives of the present study were to identify biological factors that affect ewe SCC and to

quantify the relationship between maternal SCC and lamb growth.

PROCEDURES

The MSU Agricultural Animal Care and Use Committee and the U.S. Sheep Experiment Station (USSES) Institutional Animal Care and Use Committee approved all husbandry practices and experimental procedures used in this study.

Data Collection

Milk was sampled from ewes free from CM at both MSU and the USSES during the spring of 2017. The same Rambouillet (n = 26) and Targhee (n = 30) ewes at MSU were sampled twice, the first shortly after parturition (< 5 d in milk; early) and the second before turnout to summer grazing (30 to 45 d post-lambing; peak). Milk was collected once from Suffolk (n = 38) and crossbred (3/8 Suffolk, 3/8 Columbia, 1/4 Texel; n = 46) USSES ewes at peak lactation.

Milk SCC was quantified within 3 d of collection. Blood was collected from MSU ewes into trace element vacutainer tubes and centrifuged. The resulting serum was later analyzed for trace mineral concentration.

Statistical Analyses

Milk SCC was transformed to the $\log_{10}$ scale (LSCC). Ewe LSCC within collection date and flock was analyzed with effects of ewe age [1 (USSES only), 2, or 3+], breed, and number of lambs born (NLB; 1 or 2+). A subset of MSU ewes with low LSCC (< 5.7) at both collections (LL; n = 12) and low LSCC at early and high $LSCC_A$ (≥ 5.7) at peak lactation (LH; n = 12) were identified. Serum Se and Zn concentrations were analyzed for this subset with fixed effects of $LSCC_A$ class (LL or LH) and collection date and the random effect of ewe.

Lamb weaning weights were adjusted to 120 d and summed within ewe (LWW). Total litter weaning weight at MSU was analyzed in 2 separate models that fit either early or peak LSCC as a linear covariate and the fixed class effects of ewe breed and age. The same model was used to analyze LWW at USSES, but only peak LSCC was available for these ewes.

RESULTS AND DISCUSSION

Production and biological factors influencing ewe SCC

Least-squares means of the main effects of collection date and LSCC group on MSU ewe serum Se and Zn concentrations are displayed in Table 1. Serum Se was 23.4 ng • mL^{-1} greater (P < 0.01) in peak lactation, but no difference in serum Zn was detected (P = 0.29) between collection dates. Early and peak lactation LSCC class had no effect (P = 0.39) on serum Se concentration. However, LL ewes had 0.40 µg • mL^{-1} greater (P = 0.02) serum Zn concentration than LH ewes. Zinc is involved in the production and maintenance of keratinized tissues (O'Rourke, 2009) and Saianda et al. (2007) reported that bacterial adherence to the mammary epithelium was greatly reduced in dairy ewes supplemented with additional Zn.

Ewe age, breed, and NLB did not affect (P ≥ 0.13) any ewe LSCC measure at MSU or USSES. Waage and Vatn (2008) reported that ewes rearing 3 or more lambs were 6.7 times more likely to develop CM than ewes rearing a single lamb. Additionally, Gross et al. (1978), Ahmad et al. (1992), and Arsenault et al. (2008) reported that SCC increased with ewe age.

Maternal SCC and lamb growth

Least-squares means for the main effects of ewe age and breed and solutions for LSCC on LWW are displayed in Table 2. Not surprisingly, LWW was 14.7 – 59.1 lbs greater (P ≤ 0.03) in multiparous ewes than primiparous ewes at MSU

Table 1. Least-squares means (± SE) for the main effects of collection date and LSCC class on MSU ewe serum Se and Zn concentrations.

		Serum Trace Mineral	
Effect	Level	Se, ng • mL^{-1}	Zn, µg • mL^{-1}
Collection date[1]	Early	118.7 ± 4.71[b]	1.24 ± 0.12
	Peak	142.1 ± 4.63[a]	1.42 ± 0.11
LSCC class[2]	LL	127.0 ± 5.59	1.53 ± 0.11[a]
	LH	133.9 ± 5.67	1.13 ± 0.12[b]

[1]Early, Peak = serum trace mineral concentration quantified at early (< 5 d) or peak (30 to 45 d) lactation, respectively.
[2]LL = ewes with low LSCC (< 5.7) at both early and peak lactation; LH = ewes with low LSCC at early and high LSCC (≥ 5.7) at peak lactation.
[a,b] Means within an effect and column with no superscript in common are different (P < 0.05).

at USSES. Rambouillet and Targhee ewes had similar (P = 0.88) LWW at MSU but USSES crossbred ewes weaned 27.1 lbs heavier litters (P < 0.01) than Suffolk ewes.

At MSU, LWW was negatively affected by LSCC in early (-28.2 lbs; P < 0.01) but not peak lactation (P = 0.87). However, peak LSCC reduced LWW (-32.6 lbs; P < 0.01) at USSES. According to these estimates, a ewe with a SCC of 1,000,000 cells mL^{-1} (LSCC = 6.0) is expected to wean 28.2 and 32.6 lbs less total lamb than a ewe with a SCC of 100,000 cells mL^{-1} (LSCC = 5.0) at MSU (early LSCC) and USSES (peak LSCC), respectively. In a controlled experiment, Fthenakis and Jones (1990) found that ewes induced with SCM produced 37% less milk than healthy ewes and their lambs weighed 8.8% less and consumed 25% more supplemental feed.

The SCC threshold which diagnoses SCM in sheep is not well-defined, with suggested cutoffs varying from 300,000 to 1,000,000 cells • mL^{-1} (Fthenakis et al., 1991; González-Rodríguez et al., 1995). The percentage of ewes with SCC > 500,000 cells • mL^{-1} was 19 and 17% at MSU and USSES, respectively. On average, such ewes weaned 14.1 and 48.9 lbs less lamb, a lost revenue of $31 and $106 per ewe ($2.17 lb^{-1} feeder lamb; USDA, 2018). While mean serum Zn concentration of LH ewes was considered adequate (Herdt et al., 2000), reliance upon Zn deficient forages in the months leading up to parturition and after weaning may predispose ewes to intramammary infection.

Table 2. Least-squares means (± SE) for the main effects of ewe age and breed and solutions for LSCC on LWW at MSU and USSES.

Effect	Level	LWW MSU, lbs	LWW USSES, lbs
Ewe age, yr	1	-	72.3 ± 12.0[b]
	2	77.2 ± 4.59[b]	111.6 ± 10.5[a]
	3+	91.9 ± 4.59[a]	131.4 ± 5.97[a]
MSU/USSES breed[1]	R/C	85.1 ± 4.98	118.6 ± 7.19[a]
	T/S	84.0 ± 4.25	91.5 ± 7.47[b]
LSCC[2]	Early	-28.2 ± 8.81*	-
	Peak	ns[3]	-32.6 ± 11.5*

[1]Rambouillet (R) and Targhee (T) ewes were sampled at MSU, Crossbred (C; 3/8 Suffolk, 3/8 Columbia, 1/4 Texel) and Suffolk (S) ewes were sampled at USSES.
[2]Early, Peak = LSCC quantified at early (< 5 d) and peak (30 to 45 d) lactation.
[3]ns = coefficient is not different from zero (P = 0.87).
[a,b]Means within an effect and column with no superscript in common are different (P < 0.05).

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