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An Overview of Mastitis Management and Therapy in Dairy Goats

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Abstract

Objective: This study surveys dairy goat practices, and determines the bacterial pathogens responsible for goat mastitis from samples submitted to the Hill Farm Mastitis Laboratory.

Samples: Goat milk samples (4,490) for analysis were submitted frozen to the laboratory from 67 farms across the southern United States.

Procedures: All organisms were identified using standard microbiological procedures. Staphylococcus species were identified using the API STAPH-TRAC System. Disk diffusion antimicrobial susceptibility testing, and susceptible or resistant determinations were performed following the guidelines established by the Clinical Laboratory Standards Institute. A total of 4,490 milk samples resulted in 1,033 bacterial isolates for evaluation.

Results: Staphylococcal species were the most common isolates present in milk samples. Antimicrobial susceptibility testing of representative staphylococcal isolates revealed minimal resistance to antibiotics commercially available for treatment. Of the antibiotics commercially available for intramammary infusion, cephalothin, pirlimycin and ceftiofur had the lowest percentage of resistance. Survey results revealed producers were employing a variety of mastitis treatment and control procedures and indicated a need to standardize procedures and educate producers on proven methods.

Conclusions: The *staphylococci* are the primary mastitis pathogens present is goats, and exhibit minimal antimicrobial resistance to available antibiotics. Survey results indicate a variety of mastitis control practices and treatment methods. There appears to be a lack of consistent use of proven methods and some use of folk cures and treatments not based on proven methods.

Keywords: Mastitis; Goats; Staphylococcus species; Management; Antimicrobial susceptibility

Introduction

In the United States the dairy goat is increasing in popularity, with the dairy goat inventory increasing from 290,789 in 2002 to 413,540 by 2012 [1]. Dairy goats were milked on approximately 30,000 farms. Goat milk is used for making cheese, yogurt and ice cream, and can be fed to other animals. While the sale of any raw milk is illegal in many states, raw goat milk can be used to make cheese as long as the cheese ages 60 days or more before sale. Pasteurized goat milk can be sold fresh for consumption or used for making fresh cheese. Many goat owners maintain just a few animals and produce milk for personal use only [2]. Many of these owners consume raw milk. A recent review of raw milk laws listed 16 states prohibiting the sale of raw milk for human consumption [3]. The remaining states vary on raw milk sales with some allowing on farm sale and other allowing retail sale under certain restrictions. Mastitis can have a major impact on the health and production of the animals and can also pose a public health risk when raw milk is consumed. The U.S. Food and Drug Administration has published guidelines for consumers indicating the dangers of consuming raw milk products [4], and the Center for Disease Control and Prevention noted that among dairy product-associated outbreaks reported between 1998 and 2011 79% were due to raw milk or cheese when the source of infection was determined [5]. Mastitis results in reduced production caused by inflammation of the milk producing tissue of the goats. If left untreated, this damage can become chronic and permanent. In severe cases death can result. Loss of production is the biggest economic impact; however, increased veterinary cost, reproductive issues and loss of ability to sell milk commercially can also result [6].

In recent years the Mastitis Laboratory at the LSU Ag Center Hill Farm Research Station has increasingly been asked to process milk samples from goats for mastitis. Over an eight year period from 2006 through 2014, 4,490 goat milk samples were submitted to the Hill Farm Mastitis Laboratory from 67 farms representing eighteen states. This report is a summary of the results from those milk samples, as well as, an overview of the practices to control mastitis used by producers submitting samples to this lab.

Materials and Methods

Culture of milk samples

Individual half milk samples from goats were received frozen and allowed to thaw prior to culture. Samples were plated (0.01ml) on bovine blood agar plates and incubated at 37°C for 48 hours. Producers were instructed on proper sampling techniques and samples with contamination or mixed results were excluded from the study. Samples were submitted from goats selected by producers; both clinical and nonclinical samples were included. Organisms isolated from milk samples were identified using standard methods as outlined by NMC [7]. Staphylococci were identified using the API STAPH-TRAC System. Bacterial isolates were stored frozen at -20°C in trypticase soy broth with 20% glycerin. Prior to susceptibility testing bacterial isolates were sub cultured to trypticase soy agar with 5% bovine blood and incubated for 18 to 24 hrs.

Antimicrobial susceptibility testing

A representative group of 81 staphylococci were selected for full identification and antimicrobial susceptibility testing. All organisms were identified using standard microbiological procedures [7]. Bacterial isolates were stored frozen at -20°C in trypticase soy broth with 20% glycerin. Prior to susceptibility testing, bacterial isolates were sub-cultured to trypticase soy agar plates supplemented with 5% bovine blood and incubated for 18 to 24 hrs.

Disk diffusion antimicrobial susceptibility testing was performed following the guidelines established by the Clinical Laboratory Standards Institute [8]. All tests were performed on Mueller-Hinton II agar.

Results

The 4,490 milk samples resulted in 1,033 (23%) culture positive samples. Culture results from goat samples confirmed previous reports [9,10], that coagulase negative Staphylococcus species are the predominant organisms isolated from goat milk samples. Of the 1,033 milk samples that yielded organisms, 962 were staphylococcal species. Of these 16% were *Staphylcoccus aureus* and the remainder was a mix of several different *staphylococcal* species. Of the fully identified staphylococci, *Staphylococcus xylosus* and *Staphylococcus simulans* were the most frequently isolated. Interestingly, coliforms (4%) and streptococcal species (1.8%) were isolated in low numbers.

Representative strains of the staphylococci were tested by the disk diffusion method for antimicrobial susceptibility and the results are presented in Figure 1. Antimicrobial susceptibility testing demonstrated that there was minimal resistance present in the strains tested. Of the antibiotics commercially available for intramammary infusion, cephalothin, pirlimycin and ceftiofur had the lowest percentage of resistance.

	Staphylococcus aureus (21)			*Staphylococcus simulans* (15)			*Staphylococcus xylosus* (27)			Other *Staphylococcus spp.*(18)**		
	Mean zone*	Range	% Resistance	Mean zone*	Range	% Resistance	Mean zone*	Range	% Resistance	Mean zone*	Range	% Resistance
Azithromycin	21.9	17-27	0%	21.67	19-24	0%	21.93	19-26	0%	20.72	6-29	16.70%
Clindamycin	25	20-29	0%	25	23-29	0%	21	16-27	37.00%	24	6-29	5.60%
Cephalothin	33.4	28-40	0%	33.3	32-38	0%	32.1	29-38	0%	33.6	22-45	0%
Erythromycin	25	21-30	0%	25	23-27	0%	24	12-28	3.70%	23	6-31	16.70%
Gentamicin	26.4	21-33	0%	26.1	23-30	0%	28.2	24-35	0%	25.9	15-31	0%
Levofloxacin	29	23-34	0%	27.93	22-31	0%	25.85	23-30	0%	28.67	22-33	0%
Linezolid	28.5	25-32	0%	28.4	27-30	0%	28.3	24-35	0%	28.6	24-32	0%
Oxacillin	21	15-28	0%	23	12-29	13.30%	18	12-23	48.10%	21	6-30	11.10%
Penicillin	26	14-41	57.10%	33	12-43	13.30%	29	23-37	37.00%	27	6-44	44.40%
Pirlimycin	22.6	19-28	0%	21.2	18-26	0%	21.6	17-29	0%	22.2	6-34	5.60%
Pen / Novo***	33	28-38	0%	35	19-42	0%	30	26-38	0%	32	22-39	0%
SXT****	27	22-30	0%	20	17-25	0%	26	19-30	0%	24	6-29	5.60%
Tetracycline	27	8-31	4.80%	27	24-29	0%	21	8-30	29.60%	25	8-30	11.10%
Tigecycline	24.38	20-29	0%	23.13	21-25	0%	23.26	20-28	0%	24.28	20-29	0%
TZP*****	28.57	21-37	0%	31.93	25-39	0%	30.81	27-36	0%	30.67	22-42	0%
Vancomycin	18.5	16-20	0%	18.9	16-22	0%	18.5	17-22	0%	19.9	17-24	0%
Ceftiofur	27.76	23-31	0%	27.13	23-32	0%	26.85	21-31	0%	28.83	10-36	5.60%

*zone diameter in mm from kirby-bauer disk diffusion assay

***S. epidermidis* (2), *S. caprae* (3), *S. chromogenes* (3), *S. hominis* (1), *S. hyicus* (5), *S. warneri* (1), *S. saprophyticus* (2), *Staphylococcus* spp. (1)

***Penicillin / Novobiocin

****Trimethoprim Sulfamethoxazole

*****Piperacillin / Tazobactam

Figure 1: Antimicrobial susceptibility of *Staphylococcus* species isolated from goat milk.

Survey results: A questionnaire was sent to all farms that submitted samples to determine their mastitis practices. The questions asked and the responses are listed below (Tables 1-12).

Questions and Responses from Producers

# Samples	1-10	11-20	21-30	31-40	41-50	51-60	61-70	100 plus
Totals	15	2	1	1	1	1	1	2

Table 1: Approximate # of samples submitted to the Hill Farm in the last 5 years.

	Milk	Meat	Milk & Meat	Milk & Show	Milk & Fiber
Totals	19	0	2	2	1

Table 2: Do you raise goats primarily for milk or meat?

	Yes	No
Totals	6	18

Table 3: Do you sell milk commercially? *One of the farms doesn't sell milk commercially but does sell cheese.

# Goats	1-5	6-10	11-15	16-20	21-25	26-30	31-35	46-50	No answer
Totals	6	7	4	2	1	1	1	1	1

Table 4: How many goats do you milk?

Breed	Totals
Alpine	4
Cashmere	1
LaMancha	10
Mini Alpine	1
Mini LaMancha	1
Nigerian Dwarf	1
Nubian	14
Oberhasil	2
Saanen	3
Saanen x Alpine	1
Sable x Nubian	1
Toggenburg	1

Table 5: What breed of goats do you have? *13 farms had more than one breed.

General mastitis control measures you use:

Type	Lysigin	None	No Answer
Totals	14	6	4

Table 6: Vaccines.

Type	Tomorrow (cephalothin)	Pirsue (pirlimycin)	Spectramast DC (ceftiofur)	Spectramast/2cc Gentamicin
Totals	11	2	1	1

Table 7: Dry off therapy-what type.

	Yes	No	No Answer
Totals	8	12	4

Table 8: Are all goats dry treated.

Intramammary product	Today (cephalothin)	Pirsue	Spectramast	Gentamicin	No therapy	No answer
Totals	7	10	1	2	3	6

Table 9: Lactating therapy procedures.

Systemic product	B complex	Excenel (ceftiofur)	Naxcel (ceftiofur)	Biomycin (tetracycline)	Gentamicin	Bannamine (flunixin meglumine)	No therapy	No answer
Totals	1	4	3	1	1	3	4	12

Table 10: Systemic Treatment.

Alternate treatment	Massage udder balm/ peppermint	Massage vicks vapor rub	Mega dose garlic	Vitamin C powder
Totals	1	1	1	1

Table 11: Teat dips? *Some farms gave multiple answers.

Type	Totals
Iodine	4
Udder wipes	2
Eco lab cynergy barrier (heptanoic acid)	2
Eco soft 100	1
Bac drop udder wash (phosphoric acid)	1
Fight bac spray (chlorhexidine)	3
Nolvasan (chlorhexidine)	1
Chlorhexidine	5
Tractor Supply dip	1
Blockade (iodine)	1

Teat kote (iodine)	1
Eco lab Monodine (iodine)	1
Bleach spray & commercial dip	1
Clove tea, white vinegar & dish soap	1
No answer	3

Table 12: Different types of medications used.

Discussion

Mastitis can be a serious concern for both meat and dairy goats and can result in significant loss of income in the form of lost milk production, increased veterinary costs and loss of animals due to death or premature culling [6,11]. Often mastitis in goats is subclinical and results in few or no symptoms; however, the elevated somatic cell count (white blood cell count) that results from mastitis can cause reduced milk production, and the infection has the potential to progress from subclinical to clinical with frank symptoms in the animal [6,9,11]. In addition to the animal health concerns presented by mastitis, there are also significant human health issues to consider. Milk from does with mastitis can contain large number of bacteria and some of the pathogens that cause mastitis in goats can cause disease in humans. In particular, *S. aureus* is an important pathogen for both goats and humans. The CDC notes that raw milk was responsible for 2,384 illnesses from 1998 to 2011 [5]. One third of the producers that submitted milk samples to the laboratory sold milk to the public, while the remainder used the milk for personal use. Many of these consume raw unpasteurized milk. The presence of bacteria in raw milk from these goats represents a potential source of infection [5]. Sale of raw milk is illegal in many states and use of raw milk for personal consumption is not recommended [3]. If raw milk is going to be consumed for personal use, great care should be taken to insure that the goats producing that milk are free from mastitis.

Survey results indicate a variety of mastitis control practices and treatment methods. There appears to be a lack of consistent use of proven methods and some use of folk cures and treatments not based on proven methods. Where available the active ingredient of the products appears in parentheses.

Mastitis control measures developed for bovine mastitis can be adapted to control mastitis in goats. An excellent review of these practices is available [6]. Some commonly used and easily adapted practices for control include:

Acknowledgments

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