Mas-D-Tec Mastitis Tool for Dairy Goats: Is it Useful?
2012 NE SARE Farmer Grant
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Summary

571 samples were analyzed from between 14 and 35 Anglo-Nubian goats. Each half of goats in milk were tested monthly (March to December) from the start of lactation through the end of lactation to determine the interrelationship (if any) between levels of electrical conductivity (EC) as measured by the Mas-d-tec 20 and somatic cell count (SCC) in order to determine if the Mas-d-tec 20 was a reliable predictor of subclinical mastitis in dairy goats. In addition the type of pathogens (if any) were tested for correlations.

Results show there was actually a negative correlation between EC and SCC (Pearson = - 0.10748). There was a weak but insignificant correlation between the EC readings and SCC for those 99 samples with pathogens (Pearson = -0.02429)

If the assumption is that there should be a positive correlation between higher EC and higher SCC levels as an indicator of mastitis (clinical or subclinical), then results from this study suggest that an "off the shelf" EC meter such as the Mas-d-tec 20 is not a good indicator of subclinical mastitis in dairy goats.

Introduction

In order to sell or to use milk for human consumption, standards set by the Pasteurized Milk Ordinance (PMO) determine quality and safety. These standards are measured monthly through required sampling of the bulk tank of the herd for Somatic Cell Count (SCC) and bacteria counts. SCC in cow milk must remain under 750,000 cells per milliliter of milk and 1,500,000 for goat milk. Bacteria counts are also related to milk quality, but unlike SCC, can occur either in the udder or introduced environmentally by handling of the udder or the unsanitary milking equipment or procedures. Aerobic bacteria were tested for every sample in this study.

The financial reality of reduced milk yield and therefore sales loss due to infection of the udder has encouraged research and new technologies (focused mainly on the cow industry) on inexpensive and time efficient ways to evaluate milk before major losses occur. Milk's electrical conductivity (EC) is another type of measurement that is gaining ground as an easy, inexpensive and supposed early indicator (sub-clinical) measurement of animal and milk health. Electrical Conductivity or EC, is defined as the ability of a substance to conduct electrical current. Some early studies found a concentration between EC of cow's milk and mastitis condition, and concluded that it was an accurate and rapid method of diagnosing intramammary infection.[1] Research in the cow industry indicates that infection of the udder tissue causes release of sodium and chlorine ions from the blood into the milk and as that ion concentration is raised, the milk more easily conducts an electrical current.[2] So milk from a mastitis udder has a higher concentration of these ions and therefore the electrical conductivity of the milk is higher than "normal" milk.

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[1] Park, 368.
[2] Petzer, Donkin, Du Preez, Karzis, Van der Schans, Watermeyer and Reenen, 281.

Various companies have designed a measurement tool that give EC readings with correlations to SCC, but it is important to remember that conductivity readings are not a direct measure of somatic cell count. In cows both are associated with the presence of infection, but according to research, only a general correlation exits between them.
Just are there are SCC measuring devices and testing procedures, there are a number of EC measurement devices on the market as well. They range from the relatively inexpensive "animal-side" examples, like the Mas-d-tec 20 tested in this study, to expensive automated in-line systems seen in large dairy farms. For small farmers, and especially dairy goat farmers, the idea that an inexpensive Mas-d-tec 20 retails for $375) could be used daily at the farm on each animal before obvious clinical signs of mastitis occur, would be very advantageous. Not only would it reduce testing costs, it would create efficiencies in determining which animals might need further study or immediate treatment. Knowing which animals to target and remove from the milking routine, could lead to earlier treatment, sometimes without the need for antibiotics if early enough, further specific testing (like SCC or aerobic cultures) and therefore reduce spread of contaminants to other animals, reduce loss of saleable, healthy milk and would reduce animal loss.

If a goat's reaction to infected udders is the same as cows, then EC levels will also rise for goats. This is the claim of the Wescor Company.

About the test farm – Valley View Farm, Topsfield, MA

Objectives/Performance Targets

The main objective for this project is to determine if the Mas-d-Tec 20 detector is a useful or reliable tool for dairy goat farmers in predicting subclinical mastitis. Wescor, the manufacturer of the Mas-d-tec 20, claims to be the world's most advanced early mastitis detection technology through measuring electrical conductivity. With a price point of $375 the device allows for as much individual testing, at the source, with immediate results, as the farmer wishes.

In conversations with representatives of Wescor, they indicated that the Mas-d-tec 20 that the device is calibrated for the EC of Holstein cows and that readings of over 5 are indications of mastitis. For dairy goats, they advised using fat and protein averages as the guide correlating them to similar averages of cow breeds. Nubians most closely resemble Jersey cows for their higher butterfat and protein, so Wescor recommended $\geq$ 4 as "the red zone" for detecting subclinical mastitis.

For SCC levels, in cows, a value of less than 100,000 cells/ml is considered to indicate no infection and greater than 300,000 to be from an infected udder. However, research is variable on what acceptable SCC for goats. A 2007 study of goats in the Dairy Herd Improvement (DHI) program looked at the SCC counts of dairy goats of all breeds and the data (n = 29,000) indicated significant variations ($P < 0.05$) in SCC among breeds, with Nubian being the highest, near the (then) regulatory limit of 1,000,000. Other research gives the guideline of under 500,000 as normal, 500k to 1 million as a possible weak udder infection, 1-1.5 million as possible udder health problem and 1.5 million and over as infection of the udder.

We will examine correlations over the whole data set and look at any trends within the range of EC, SCC, pathogens etc., observed. Ideally, the target goal would be a positive correlation between

rising Mas-d-tec-20 readings and actual SCC or relationship between pathogens and consistent EC readings.

Methods

Collection of milk samples
571 milk samples and readings were obtained monthly from each half of each goat at the start of their lactation through dry-off in December. Readings and collections were taken during the morning milking routine. Goats were milked at 12-hour intervals, using a low-line milking machine. On the sampling day, the teats were washed, dried, and stripped and the foremilk was used for samples.

The Mas-d-tec 20 is a portable hand-held electrical conductivity meter having a funnel-like opening at its top. The instrument is equipped with a single flow cell with a 0-9 digital display (i.e. – 10 sensitivity levels). Approximately an ounce is squirted in circular fashion and a reading is depicted on a scale of 1 to 9, with the higher numbers theoretically indicating the most infected udder. A score for each half of each milking was recorded.

After the Mas-d-tec reading, a SCC sample was then taken in a 3 ounce vial and sent to Dairy One of Ithaca, NY. The SCC was measured on the Fossomatic FC, an automated electronic fluorescent microscopic somatic cell counter (Foss Electric, Hillerod, Denmark). Finally, the teats were cleaned with an alcohol swab and 1.5 oz aerobic sample was taken and sent Quality Milk Production Services (QMPS) of the Animal Health Diagnostic Center of Cornell University. These samples were tested using the "Sub-Clinical" procedure, as the animals did not exhibit any outward signs of mastitis. The sample milk is streaked directly onto a blood agar-esculin plate.

Statistical Analyses
Data were analyzed for linear dependence using the Pearson correlation coefficient, means, median and correlations amongst different parameters of the milk samples.

Outcomes and Impacts
571 EC readings were taken and 571 SCC and pathogen samples. Table 1 shows the breakdown of the samples at EC reading level for SCC counts, <500k, 500k-1.5 million and >1.5 million and the number of samples that had pathogens for each EC reading level. The overall average (mean) of the 571 readings was an EC display 4.60 and 5 was the median reading. The SCC mean for all 571 samples was 817,980 and the median 253,378, both under the 1.5 million threshold. Looking at SCC at any reading level EC, 381 of the 571 samples had levels under 500,000 (67%). 127 (22%) had SCC levels between 500,000 and 1.5 million and 63 (11%) had SCC over 1.5 million.

Wescor's claims indicate a positive correlation between the EC readings and the SCC count. This was not found in the testing. A scatter plot (Chart 1) and Pearson linear correlation between EC and SCC readings of all samples, shows a weak negative linear correlation (-.10748).

According to Wescor, readings higher than 3 indicate likely udder infection. 389/571 samples had EC readings $\geq$ 4 (68%) with an average SCC of 650,575 and a mean SCC of 230,373. Both are less than the whole data set's equivalents and are also well under the threshold of 1.5 million. 69% of those with readings $\geq$ 3 had SCC readings less than 500k, the number considered for this study as the threshold for a healthy udder. 92% (357) had SCC less than 1.5 million, the bulk tank limit.

Only 8% of those samples with EC readings ≥ 4 had SCC over 1.5 million.

Samples with Pathogens
99 (17%) of the total samples were found to have bacteria present. There were three types of pathogens found, 95 had Coagulase-negative Staphylococcus (Staph spp. or CNS), 3 had Streptococcus agalactiae (Strep ag.) and 2 had C. species, with no growth. For these 99 samples, the mean EC was 5.07 and the median 5.0, slightly higher than the whole set. There was no correlation between the EC readings and SCC for those 99 samples with pathogens (Pearson = -0.02429), Chart 2.

Accomplishments
This study was unable to find a consistent, reliable, direct or obvious relationship between the Mas-d-tec 20's electrical conductivity readings and evidence of sub-clinical or clinical mastitis and in fact, favored negative predictive value. In cases where SCC was high and/or pathogens were present, EC levels did not correlate to indicate infection.

Interestingly, SCC levels and pathogens did not strongly correlate either. Dairy goat owners should not turn to "off the shelf" EC measurement devices, created for the bovine milk industry as a tool for udder health management.

Potential Contributions
During this study 35 goats were observed and monitored very closely throughout the lactation season. Yet, tracking EC and SCC and pathogens gave no clear, reliable or early indication of problems in the health of the mammary systems. Oftentimes, there were no elevated EC, SCC or pathogens, and yet clinical signs were present. What this indicates is the need for greater research in what is causing and ways to predict what is causing those clinical signs before they become clinical.

Publications/Outreach
This article or version of it will be submitted for publication to the Dairy Goat Journal and United Caprine News. It will also be sent to the American Dairy Goat Association.

Future Recommendations
Further Information about Somatic Cell Count as an Indicator of Mastitis in Dairy Goats
A sidebar outcome of the results of this study as well as research examined for it, calls into the question the reliability of SCC being used as a measurement tool for the health of milk and udders in dairy goats. Like electrical conductivity, SCC characteristics and behavior in goat milk has been assumed to be the same as in cows and the measurement devices and standards have been utilized with limited validation from actual research on dairy goats. Cows and goats are different species and it stands to reason that there are some biological differences in their mammary systems.

Milk Secretion in Cows vs. Goats
Mammary glands are considered skin glands made-up of connective tissue (fatty and fibrous) and secretory tissue. However, there is a difference between cows and goats in how they secrete milk from their respective mammary glands. Cows secrete through alveolar merocrine secretion in which honeycomb-type cells remain undamaged during the secretion of the milk, so only the milk is released. Goats secrete through a process called apocrine secretion in which the tip of the

secreting cell is released along with the milk.[3] This sloughing of epithelial cells by goats and any leukocytes from the milk ducts along with the milk is the key difference in between the species.[4]

Somatic Cell Counts and Clinical vs. Subclinical Mastitis

Somatic cells are white blood cells (leukocytes) and are the defense against bacteria that penetrate the physical barrier of the udder's teat canal and cause mastitis, which is the inflammation of the mammary tissue.[5] The cells are produced all the time and they are always there floating around in the blood stream, and are shed to some degree in healthy milk. These cells are involved in repairing the damage and destroying the bacteria. The diagnosis of mastitis is based on the premise that the animal has an increase in its shedding of somatic cells. When the infection or damage to the udder occurs, the body sends higher numbers to the injured or infected site.

The inflammation of the mammary gland can lead to eventual damage of those udder tissues, including permanent damage. Clinical mastitis is obvious in that it can cause fever, discomfort, lop-sidedness or swelling, produce abnormal milk, reduction in production and sometimes, eventual death. Sub-clinical mastitis is more problematic because no visible changes appear in the milk or the udder, but as with clinical mastitis, milk production decreases, bacteria are in the milk, and the composition of the milk is altered. These changes can reduce cheese and butter yield, change acid production in fermented products and lead to distaste in all kinds of dairy products.

The theory is that when there are elevated levels of either SCC or bacteria in the tank, farmers will start to evaluate individual animals as well as their milking routine and equipment to see where the problem(s) lies. Larger cow farms may have "cow side" or "inline" SCC counters and very sophisticated equipment tracking cow's information.

Counting Somatic Cells

There are a number of ways to measure or count somatic cells (SCC). Some "animal side" tests like the California Mastitis Detector (for cows and goats) and the Portacheck (for goats) don't actually count cells, but rely on the tester's visual interpretation of results against included charts calibrated to SCC counts. Actual lab testing for SCC includes Direct Microscopic Somatic Cell Count Guideline (DMSCC) or Electronic Somatic Cell Count. DMSCC is where somatic cells contained in a representative and specific quantity of milk sample are transferred to a microscope slide, stained, and counted using quantitative microscopic techniques. Ideally, the lab differentiates the stain depending on whether they are testing cow's milk or goat's milk. The Blue Stain is used for cows and stains both somatic cells and cytoplasmic particles, the latter, which are few because in cows, the milk secretion system does not shed these latter types of particles. The Green Stain (pyronin y-methyl green) colors only nuclear material (just the cell DNA in somatic cells and not the cytoplasmic particles or epithelial cells). The latter is considered the best type of tests for an accurate measure of SCC in goat milk, but there are no state approved labs in Massachusetts conducting the green stain.[6]

In electronic somatic cell count, the machine electronically enumerates the somatic cell count in a given volume of milk. These counters do not differentiate between epithelial, cytoplasmic mass

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[3] Petzer, Donkin, Du Preez, Karzis, Van der Schans, Watermeyer and Reenen, 280.
[4] Escobar, 3.
[5] Escobar, 1.
[6] Haskell, 7.

and white blood cells and therefore are biased against the secretion design of goats. Most regulatory approved labs use electronic counting due to their speed and convenience, and since the vast majority of the dairy business in cows' milk, the blue stain method is the calibration for electronic counting. Therefore, because there is no differentiation between the types of cells, it causes goat (and sheep) milk to appear to have a higher somatic cell count than cow milk.[7]

Studies have compared direct green stain testing against electronic counters calibrated for goat milk and cow's milk. If the machine is calibrated for goat milk, the results are comparable between direct green stain counting and the electronic counter. If the electronic counter is calibrated for cow's milk, depending on the machine, the results can be 24.5-27%% higher than the green stain testing.[8]

More research needs to be undertaken that utilize testing procedures geared specifically to dairy goat to create better and more specific standards for constitutes mastitis and healthy milk in a goat**.** This study results showed that changes in electrical conductivity might not be a reliable predictor for mastitis in dairy goats. It did show (as many other studies do), that there is a positive correlation between the month of lactation and SCC increases (as measured by the Fossomatic counter), but no corresponding increase in pathogens present in the milk. Rising levels of SCC alone does not seem to indicate the presence of mastitis or unhealthy milk. It also shows that butterfat and protein are positively correlated to SCC and go up at the end of lactation. Does it simply mean the milk's chemical composition changes with the season? If so, what does this mean for the quality (not necessarily health) of the milk for human consumption or cheese production?

Hopefully, with the increasing number of dairy goat farmers and the resurgent interest in consuming goat milk, more state laboratories will employ the green stain method in order to accurately count actual somatic cells in dairy goat milk. In the meantime, determining sub-clinical mastitis in dairy goats remains very challenging for the farmer.

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[7] Dulin, Paape & Wergin, 1982.

[8] Escobar, 3., 1995 Langston University letter to Dave Patterson, Agrimark.

Table 1: Total Sample Pool breakdown for SCC and Pathogens by EC levels.

EC Reading	# Samples	% of total	U500k	%	500k – 1.5million	%	Over 1.5 million	%	Pathogens
0	32	7%	16	50%	10	31%	6	19%	1
1	29	5%	13	45%	7	24%	9	31%	5
2	56	10%	37	66%	12	21%	7	13%	10
3	65	12%	47	72%	9	14%	9	14%	10
4	68	12%	49	72%	15	22%	4	6%	13
5	91	17%	66	73%	16	18%	9	10%	12
6	109	19%	83	76%	19	17%	7	6%	18
7	75	11%	48	64%	21	28%	6	8%	21
8	32	6%	19	59%	11	34%	2	6%	4
9	14	2%	3	21%	7	50%	4	29%	5
Total	**571**		**381**	**67%**	**127**	**22%**	**63**	**11%**	**99**

Chart 1: Mas-d-Tec/EC correlated to SCC scores. R = -.10748.

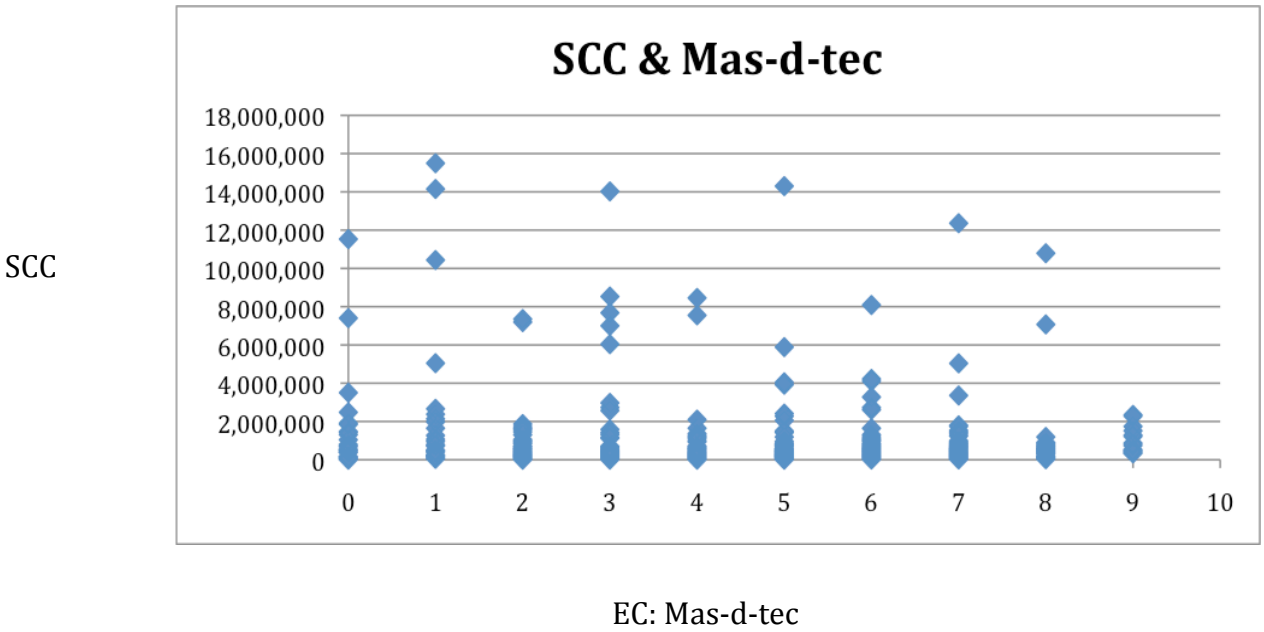
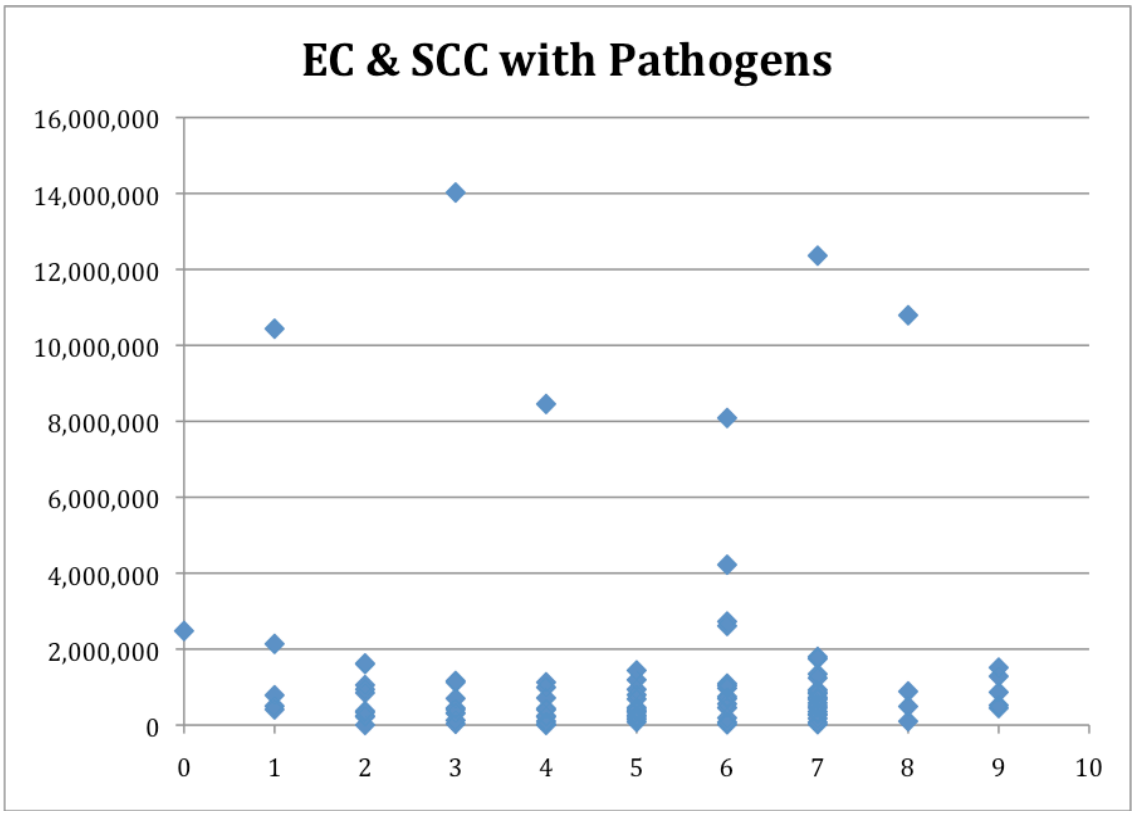


Chart 2: Mas-d-Tec/EC correlated to SCC scores with Pathogens. R = 0.02429.

SCC



EC: Mas-d-tec

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