

Measuring the electrical conductivity of milk can help with the early diagnosis of mastitis.

Curb mastitis with fast diagnosis

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Mastitis remains the most costly disease of dairy cows in South Africa and worldwide.

Everybody knows that the best solution is prevention, but as this is not entirely possible, early detection of true mastitis cases is economically profitable.

But how effective is electrical conductivity and the California Milk Cell Test (CMCT) for mastitis diagnosis? The benefit for the affected cow lies in shortening the duration of infection, which in the majority of cases can lead to less udder damage thanks to a less severe infection of the udder.

On the other hand, if the duration of mastitis infection with mainly contagious mastitis (also called host-adapted bacteria these days), namely *Staphylococcus aureus* and *Streptococcus agalactiae*, increased, so does the possibility that other cows within the parlour may become infected.

The indirect effects of mastitis are often overlooked when a cost-benefit analysis is done.

According to the International Dairy Federation (IDF), a cow-side test can be used if it is accurate enough to diagnose

at least 70% of true positive cases (mastitis cases) correctly and indicate at least 99% of true negative cases.

This sounds very good, but in a practical situation this will mean: If a producer is milking 250 cows twice a day (500 cows milked per day), one out of every five true mastitis cases will be missed and five cases per day will be identified as mastitis cases, although false alerts (research by Mein, 2010).

Therefore, out of the nine cases diagnosed by the test only four will be correct. If the accuracy can be increased, this scenario may improve drastically.

Local testing

In a recent study done in South Africa, 1 860 quarter milk samples were taken from eight dairy farms. Quarter milk samples were taken aseptically for laboratory analysis, followed immediately by a milk-electrical resistance (MER) test and the CMCT.

The MER test is the inverse of conductivity. The results of these two test and laboratory



Millions of litres of milk are lost every year due to mastitis and non-saleable milk during the withdrawal period of cows treated for mastitis infections.



The tried and tested benefits of the California Milk CellTest (CMCT) method of testing for mastitis are simple, effective and profitable.

results (somatic cell counts and microbiology) were used to determine the cut-off points that were the best to use to diagnose true mastitis and true healthy udders with the electrical conductivity and CMCT.

The aim of this study was to determine how accurate the CMCT and electrical conductivity tests were and what the advantage would be (if any) if these tests were done in parallel.

To use both tests may be practical for producers who already have in-line conductivity measurement devices. Cases that show an alert on this system could be followed up with the CMCT.

The findings of this study were further used to estimate cost implications of using the CMCT and electrical conductivity tests separately and combined, using a cost-benefit model. As mentioned, misdiagnosis of mastitis by cow-side tests increases the duration of the udder infection and possible udder damage when treatment of contagious mastitis pathogens (*Staphylococcus aureus* and *Streptococcus agalactiae*) is postponed until the dry period blanket therapy.

How the model works

Partial budgeting (looking at a section of the costs) was used to estimate benefits and costs of the mastitis-control programme to producers, taking into account the milk loss, treatment costs and costs to perform the cow-side tests.

This partial budget analysis was then used to develop a cost-benefit model that estimates the net cost of benefits in rand value, of using the CMCT and electrical conductivity separately on their own or the two tests done in parallel for more accurate mastitis diagnosis.

Input variables were based on current South African economic conditions at the time of the test and on literature. Direct and indirect effects of diagnosing and misdiagnosing cases were taken into account and calculated at cow level.

Prices used for model inputs: The cost of treatment was calculated taking the cost of the intra-mammary antibiotics and the number of treatments necessary into account. Milk loss was calculated taking things such as the milk price, milk yield

per cow per day and milk loss due to antibiotic withdrawal into account. The cost of the CMCT and electrical conductivity were calculated per test. Although in-line conductivity is widely used in practice, the hand-held electrical conductivity meter was used in this study in order to get readings per quarter for comparison with the CMCT.

Model inputs: The following four scenarios were analysed for the CMCT, electrical conductivity and a combination thereof.

1. Effects of correct diagnosis of mastitis on cost-benefit outcome.
2. Effects of missing mastitis animals on cost of error per cow.
3. Effects of correct diagnosis of healthy udders by the tests (this is good and has no cost implications).
4. Effects of missing healthy udders on the cost of error per cow.

Results: The most effective cut-off points established for the CMCT test were "1+, 2+, 3+" for a positive result and "0" for a negative result. If the difference in CMCT result between quarters of a cow was more than 15% (two unit CMCT score difference), for example a score of "0" and "2+ or 1+ and 3+", that cow should also be seen as suspect and followed up.

For the electrical conductivity test the cut-off points established were indicated by an orange light (score 24-31) or red light (score <24) for a positive result, while a negative result was indicated by a green light (score >31). The electrical conductivity was measured in milli-Ohms per centimetre (mΩ/cm).

Findings

The CMCT was found to be a third more effective than the MER test and more cost-effective in diagnosing mastitis compared to the laboratory Gold Standard used.

However, using both tests in parallel was shown to be almost twice more beneficial than the electrical conductivity test and a third more beneficial than the CMCT.

It can be seen from the table that using the CMCT on its own (R898,73), or the CMCT and the electrical conductivity test together (R1 064,67), were effective in identifying mastitis animals. Using the electrical conductivity test on its own (R518,70) was less effective (Table 1).

The partial budgeting cost-benefit model showed that using the two cow-side tests combined (CMCT + electrical conductivity) had the highest total expected benefit of a correct test per cow (R1 123,99) and the lowest total expected error of an incorrect test per cow (R52,50).

Table 1: Summary of cost-benefit model showing expected costs and benefits of the CMCT and electrical conductivity test done separately and combined, taking cost of test per cow into account.

Summary	CMCT	EC	Combination
Expected benefit of correct test per cow	R1 038,34	R778,67	R1 123,99
Expected cost of error of incorrect test per cow	-R138,15	-R254,61	-R52,50
Cost to conduct test per cow	-R1,46	-R5,36	-R6,82
Total expected benefit of test per cow	R898,73	R518,70	R1 064,67

The most effective method for identifying true negative animals was using the two cow-side tests combined.

The combined cow-side tests (CMCT + electrical conductivity) can be beneficial when used strategically in practice by enabling producers to diagnose mastitis caused by contagious organisms at an early stage. Early diagnosis reduces herd infection rate, minimises udder damage and promotes a pro-active approach to udder health management.

Although CMCT on its own is more effective than electrical conductivity used on its own, in-line conductivity is currently available in most commercial dairies. Thus when an alert is given by the in-line conductivity meter, that animal should be followed up, using the CMCT.

In the case where both cow-side tests are positive, indicating a strong possibility of mastitis, the cow should be placed in a separate group, milked last and treated in order to minimise udder damage and exposure to contagious infections in the herd, as early detection and prevention are better than cure.

Calibrate for best results

Calibration of a CMCT spatula is necessary to prevent inaccurate results. Here is how it is done:

The following materials are necessary for the calibration of the CMCT spatula:

- 10ml or 20ml syringe (not sterile but clean).
- A pocket knife.
- A black permanent marker.
- All of the CMCT spatulas.

Determine the volume that is delivered by the plunger on the CMCT container. Take care to ensure that there is no air in the plunger, as this will give an incorrect volume.

Press the plunger a few times until the reagent that comes out forms a steady

stream. The volume that the plunger delivers is measured by pressing the plunger for its full length three or four times into a syringe.

Read the volume on the syringe and divide it by the number of times that the plunger was pressed to determine the average volume.

Squirt the exact calculated volume of the reagent into the spatula's far right cup. Tilt the spatula until the reagent is about to overflow.

Use the pocket knife to mark the fluid line on the surface of the spatula. Pour the reagent out, rinse and dry the spatula and mark the line clearly with a permanent marker.

The spatula is then calibrated for the specific reagent's plunger.



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Read more

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For performing and reading the CMCT test, refer to previously published articles by Prof Petzer, *Udder health tests – California Milk Cell Test (CMCT) Part 1 and 2* in *The Dairy Mail* of August 2010 (p67-69) and September 2010 (p75-77). 