FOSS

Somatic Cell Counting
The way to control Mastitis and improve dairy product quality

Mastitis ...

1. Introduction

Mastitis is the most costly disease on the dairy farm today. Total losses for the United States are in the range of 1.5 to 3 billion USD annually, or 11% of the total USA milk production.

Nearly 70 % of this loss is a result of reduced milk production caused by sub-clinical mastitis.

The only practical way to measure this hidden mastitis is by monthly recording of the somatic cell count.

The dairy industry is aware of the impact of raw milk quality on finished dairy product quality. Mastitis, indicated by a high-level somatic cell count has a very negative effect on product quality, due to increased enzymatic activity, coming from both proteolytic and lipolytic enzymes. This effect will reduce cheese yield, butter yield, change acid production in fermented products and lead to taste defects in all kinds of dairy products.

"somatic cell counts greater than 500.000 cells/ml indicates that one third of the mammary glands are infected and that the loss of milk due to sub-clinical mastitis is at the least 10 %"

To encourage farmers to lower the level of somatic cells, many dairies offer premium payment programs for milk with low somatic cell level, and reduction in payment for milk with high somatic cell level.

Dairy Herd Improvement (DHI) supports the farmers by monthly milk recording and testing for somatic cells on individual cows. The farmer can used the results to fight sub-clinical mastitis and by that optimise milk production both concerning the amount and the quality of the milk.

2. Mastitis

Mastitis is an inflammation of the mammary gland and is usually caused by bacteria infection of the udder tissues. This infection will result in an increased number of somatic cells (white blood cells), which is the defence mechanism of the cow's body. Its primary function is to eliminate infections and repair tissue damage.

Mastitis can be clinical or sub-clinical. Clinical mastitis gives abnormal milk and swelling of the udder. Bacteria are present in the milk, and the composition of the milk is dramatically changed.

Sub-clinical mastitis is more problematic because no visible changes appear in the milk or the udder, but milk production decreases, bacteria are in the milk, and the composition is altered.

Mastitis is often contagious and therefore it is important to know which cows are infected. There are 15-40 cows infected with sub-clinical mastitis for every cow with clinical symptoms. The first sign of infection is the increase in somatic cell count. Cows with persistent high cell count that carry over from one lactation to the next are prime candidates for culling.

3. Somatic cells

Somatic cells are constantly circulating in the blood stream and when infection or damage occurs, the body sends high numbers to the injured site. There are a few different types of cells. The first type, which is the phagocytes (neutrophils) are present in the largest number and their purpose is to phagocytize or engulf bacteria. The second type which is lymphocytes are present in much smaller numbers but play an important role in controlling the immune response and produce antibodies facilitating the destruction of the bacteria.

A high number of somatic cells indicates that the immune system is in a state of alert.

... affects milk payment

Several studies have proven that there is a close relationship between infections in the udder, the milk quality and the number of somatic cells.

4. Different levels of somatic cells

When the milk of all cows in a herd is mixed, as in a bulk tank, the somatic cell count in a composite sample is a good indicator of the prevalence of mastitis in the herd. A somatic cell count greater than 200.000 cells/ml indicates the presence of sub-clinical mastitis. Somatic cell count under 400.000 cells/ml are typical of herds that have good management practices, but no particular emphasis on mastitis control. Herds with an efficient mastitis control program consistently have counts below 100.000 cells per ml. In contrast, somatic cell counts greater than 500.000 cells/ml indicates that one third of the mammary glands are infected and that the loss of milk due to sub-clinical mastitis is at the least 10 %.

"There are 15-40 cows infected with sub-clinical mastitis for every cow seen with clinical symptoms."

5. Milk payment systems

Udder infection influences the contents of all the important components in the milk, and the somatic cell count is therefore widely used as a payment parameter.

In 1992 a cell count limit of 400.000 cells per millilitre was included in the EU hygiene directive as the allowable limit for using cows milk for human consumption. In Australia and New Zealand the limit is 400.000 as well. In USA the legal limit is 750.000 cells/ml and in Canada the limit is 500.000 cells/ml However, this limit has only minor importance for most farmers today because in many countries the average count is now well below 250.000 cells per millilitre.

This has led to even lower payment limits as well as bonus agreements for milk with somatic cell count below this limit.

In Denmark the farmer will be paid extra if the total cell count in the bulk milk is below 300.000 cells per ml. If the count is higher than 400.000 cells per ml the payment will be reduced - at 600.000 cells/ml the payment is reduced by 0.02 EU per litre.

6. Dairy Herd Improvement

In many dairy countries, farmers are members of Dairy Herd Improvement (DHI) organisations, which are offering farmers milk recording up to 11 times per year. This includes analyses for somatic cells, fat and protein. These results will provide helpful management information for farmers, veterinarians and other mastitis control team members in their efforts to set up a program for an efficient mastitis control.

In Denmark the average cell count was 405.000 cells per millilitre in 1989 and today the average is about 175.000 cells per millilitre. Even with this reduction, approximately 1/3 of the cows still have more than 300.000 cells per millilitre.

In many dairy countries up to 80% of the dairy farmers are members of the local Dairy Herd Improvement (DHI) organisation. The membership will result in increased income for the farmer.

Counting somatic cells in raw cow milk is often carried out at large central milk testing laboratories, where the number of samples can be several millions per year. These laboratories are either privately owned or owned by the DHI organisation. (More about DHI in the FOSS publication "Dairy Herd Improvement".

... affects farm economy

7. What does mastitis cost the dairy farmer

Mastitis is the illness per lactation with the highest frequency. The following figures are from Denmark:

	Percentage cows with one or more incidents		
Lactation number	**Mastitis**	Retained Placenta	Milk fever
1	**18.5**	5.8	0.1
2	**20.6**	8.1	1.7
3	**23.7**	9.5	7.1
4	**26.5**	10.9	17.2

Source: Danish Agricultural Advisory Centre rapport no 4 1991

The cost can be split up as follows:

- Veterinarian costs
- Antibiotics
- Retained milk
- Decreased yield
- Less payment for the milk
- Culling

The total loss per incidence of mastitis has been calculated to be approximately USD 250-300. (Danish Agricultural Advisory Centre 1991)

Reduced yield accounts for approximately 70% of the total loss associated with mastitis. With a somatic cell count of 400.000 cells per ml, the yearly loss in milk volume will be about 5-8% per cow – not counting the reduced level of fat, protein and lactose in the milk.

The following table shows how much an increase in somatic cell counts in the milk costs the farmer.

Single cow SCC Cells/ml	Single cows Yield loss per lactation Kg/cow	USD loss with 50 cows in herd Milk price 0.3 USD/l
25.000	0	0
50.000	0	0
100.000	180	2700 USD
200.000	360	5400 USD
400.000	540	8100 USD
800.000	720	10.800 USD
1.600.000	900	13.500 USD

8. How does mastitis influence milk quality

From a dairy point of view, mastitis has a negative influence on the different milk components and leads to quality problems in the final dairy products. The changes due to increased somatic cell count can be summarised in the following table:

Factor	**Increase**	**Decrease**	**Effect for the Dairy**
Fat		**X**	Economy, less butter yield
Free Fatty Acids	**X**		Rancid taste
Total Casein		**X**	Less cheese yield, up to 1 % per 100.000 cells
Lactose		**X**	Economy
Sodium	**X**		Salty taste
Chloride	**X**		Salty taste
Calcium		**X**	Quality of the product
Lipase	**X**		Increase in Free Fatty Acids

Source: Danish Agricultural Advisory Centre

The enzymatic breakdown of milk protein and fat are responsible for the quality defects seen in dairy products from milk with increased somatic cell count.

Fat, lipases and free fatty acids

An increased level of somatic cells negatively affects the milk fat. The contents of free fatty acids is increased, and lipase activity gives rancidity problems in dairy products. The butter yield is reduced and the quality of the butter is affected.

Milk proteins

The amount of protein in milk decreases as somatic cell count increases. This is due to the increased proteolytic enzyme activity in the milk. One of these enzymes is plasmin that breaks down casein during milk storage. Plasmin comes from the blood plasma into the milk through damaged mammary tissue. The change in total protein is not high, but the percentage of casein decreases while the percentage of whey protein increases.

... affects dairy production

Lactose and sodium chloride

An increase in somatic cells reduces the level of lactose and increases the level of sodium chloride. This is the reason why milk with high somatic cell numbers is often graded as being salty.

If mastitis milk is mixed with milk of good quality in the milk silo tank, the result is a damage of casein and fat in the good milk.

9. Influence on cheese and fermented dairy products

High somatic cell count has a very negative influence on dairy products. The main protein in cheese is casein and it will be reduced by nearly 20% when the somatic cell level is high, resulting in lower cheese yield.

The table below shows the changes in milk from normal to high somatic cell count.

	Normal milk %	Milk with high SCC	% of normal
Solids-non-Fat	8.9	8.8	99
Fat	3.5	3.2	91
Lactose	4.9	4.4	90
Total Protein	3.6	3.56	99
Total Casein	2.8	2.3	82
Whey Protein	0.8	1.3	162
Sodium	0.057	0.11	184
Chloride	0.091	0.15	161
Calcium	0.12	0.04	33

Source: National Mastitis Council, 1996

Cheese:

The changes in the milk components result in following problems in cheese production:

- Increased milk pH
- Reduced fermentation of the cheese milk
- Problems with the coagulation and the firmness of the cheese curd
- Increased water content in the cheese
- Changes in texture
- Changes in the maturation of the cheese

The cheese yield will decrease by up to 1 - 4%, depending on the level of somatic cells.

Average Somatic Cell Count	Cheddar cheese kg cheese/100 kg milk
240.000	9.748
496.000	9.686
640.000	9.430

J.C Bruhn U.C Davis 1983

In the figure above, the loss in cheese is 318g per 100 kg milk when the somatic cell count increases from 240.000 to 640.000, equal to 3.26%.

Mastitis milk also has a negative effect on starter organisms, which results in slow cheese vats. Furthermore the coagulation time increases due to lower casein and calcium content.

If a dairy produces cheese from 15 tanks containing 20,000 litres of milk each, this gives a production of about 30,000 kg of cheese per day.

With high somatic cell count (600,000 cells/ml), the cheese yield will be reduced by not less than 2% - equalling 600 kg per day. This is close to **USD612,000 per year** (600 kg x USD3.40 per kg cheese x 300 production days).

Liquid milk and fermented products:

In liquid milk, the rate of off-flavour development increases. Rancid off-flavour due to increased lipase activity, bitter flavour due to proteolytic enzyme activity and salty flavour due to a change in milk mineral balance will all

gradually appear as somatic cell count increases.

For fermented products such as yoghurt, the protein breakdown could cause a weak body and result in undesirable separation of the yoghurt into curd and whey in the package. Furthermore, the acid production in yoghurt will be slower due to the higher level of immunoglobulin in the milk.

Conclusion:

For the dairy industry as a whole, profits can be increased considerably if the farmers succeed in reducing somatic cell count in the milk.

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