Mastitis: The disease under aspects of milk quality and hygiene

By W. H. Heeschen and J. Reichmuth

Institut für Hygiene der Bundesanstalt für Milchforschung, Kiel

1. Introduction

Milk quality (1) is determined by parameters of composition and hygiene. The compositional quality of milk is mainly influenced by feeding, management systems, genetics, breed and other factors. The hygienic quality of milk is influenced by pathogenic microorganisms, saprophytic microorganisms, residues, contaminants, flavour and some others.

The qualitative hygienic requirements to be met by raw milk and milk products vary between categorical postulates for protecting human health and desirable properties, which are – from the nutritional point of view – conducive for optimal consumption. Milk (and milk products) of high qualitative hygienic value should have

- low numbers of saprophytic microorganisms,
- absence or very low numbers of pathogenic or potentially pathogenic microorganisms including mastitis pathogens,
- no residues of toxicological relevance due to measures of mastitis prophylaxis and control and
- minimum amounts of contaminants, transferred by – for example – feeding stuffs.

All the measures necessary to obtain milk and milk products with a high qualitative and hygienic standard are summarized in the term "food hygiene". Hygienic measures should guarantee a foodstuff, which is clean, safe, sound and wholesome (Table 1) (2).

Tab. 1: Food Hygiene

Food sanitation	Food safety	Food protection	Food preservation
clean	safe	sound	wholesome

Moreover, standards of quality and hygiene have to be discussed considering the Agreement on Sanitary and Phytosanitary Measures (SPS) within the General Agreement on Trade and Tariffs (GATT). Hygienic parameters should not form Technical Barriers to Trade (TBT), and in so far negatively influence the trade between countries and worldwide. Codex Alimentarius with its special committees (Codex Committee for Food Hygiene (CCFH), Codex Committee for Residues of Veterinary Drugs in Food (CCRVDF), Codex Committee for Milk and Milk Products (CCMMP), Codex Committee on Food Additives and Contaminants (CCFAC) and the Joint Expert Committee on Food Additives and Contaminants (JECFAC)) have high responsibilities in the future as advisors for the incoming World Trade Organization (WTO). The International Dairy Federation (IDF) has the status of an official advisor of the Codex Alimentarius, and this underlines the importance of the IDF activities in the mastitis area and the influence of this disease on aspects of quality and hygiene of milk and milk products and the worldwide trade (3).

In the following some important aspects of mastitis and the influence on compositional and hygienic quality of milk will be discussed taking into consideration the legal situation within the European Union (EU) as an example and future trends worldwide. Even if measuring methods are not covered within this paper, their significance for evaluating and interpreting standards of quality and hygiene cannot be overestimated.

2. Mastitis: Influence on the compositional quality and the technological properties of milk

Inflammations of the mammary gland and disturbances of secretion lead to alterations in the composition and of chemical-physical properties of the milk (4). These changes are significant under nutritional and technological aspects. Major and minor components of the milk including protein, fat, lactose, anions, kations and enzymes are influenced. The influences of mastitis milk on the compositional and technological quality of raw milk are summarized in Figures 1 to 7 (5). Depending on the number of somatic cells it can be seen that the composition of the milk, the enzyme activity, the rennet clotting time and the yield and quality of products are negatively influenced.

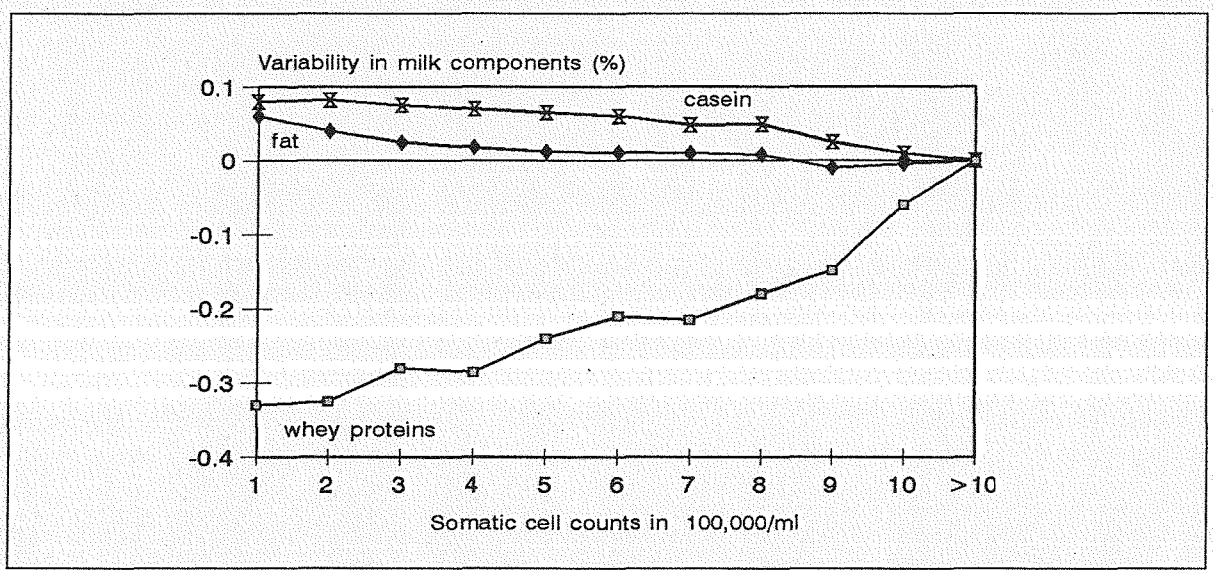

Fig. 1: Variability of fat and protein components in milk for different somatic cell counts (5)

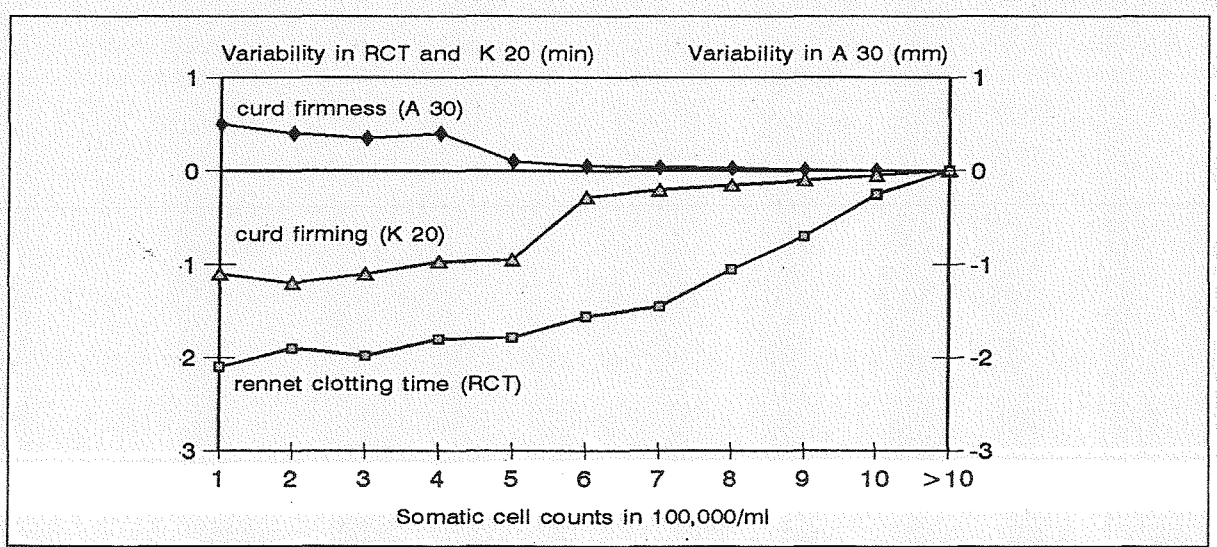

Fig. 2: Variability in rennet clotting time, rate of curd firming and curd firmness for different somatic cell counts (5)

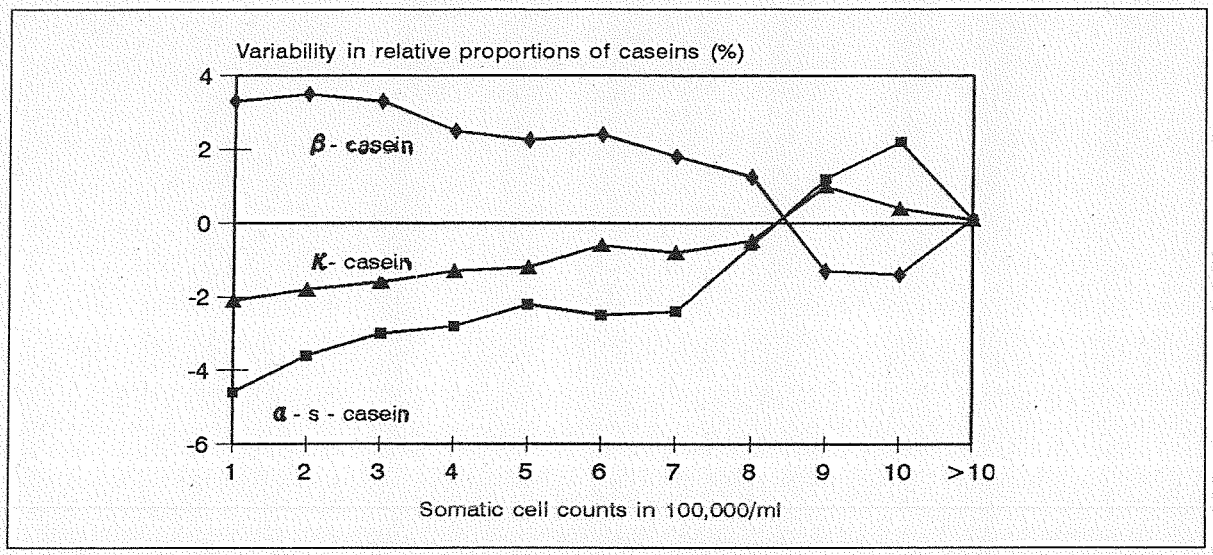

Fig. 3: Relative proportions of α_s-casein, β-casein and κ-casein for different somatic cell counts (5)

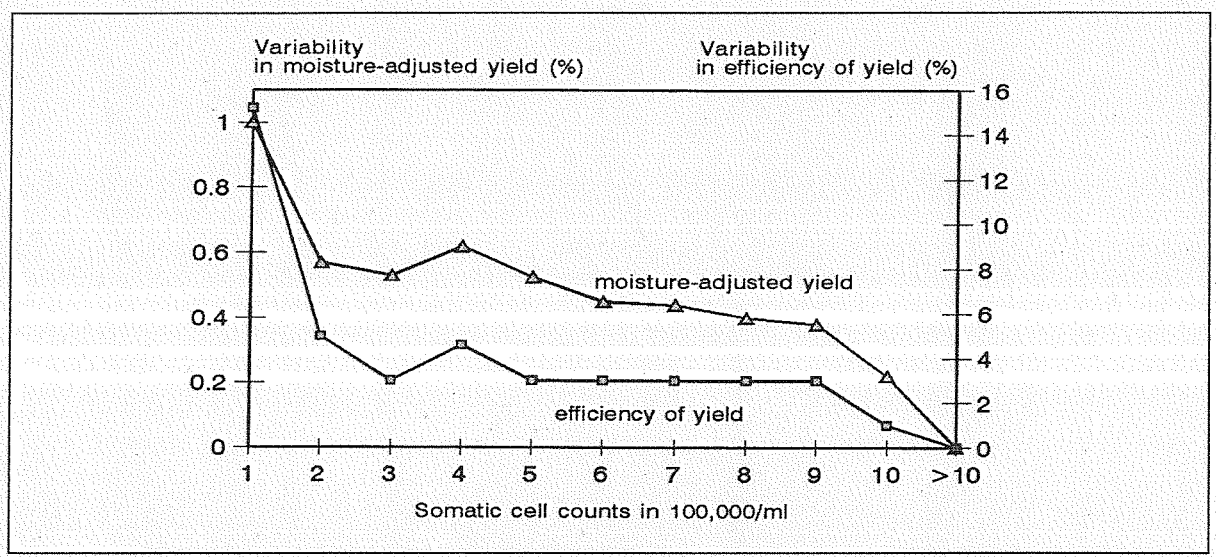

Fig. 4: Moisture-adjusted yield and efficiency of yield of cheese for different somatic cell counts (5)

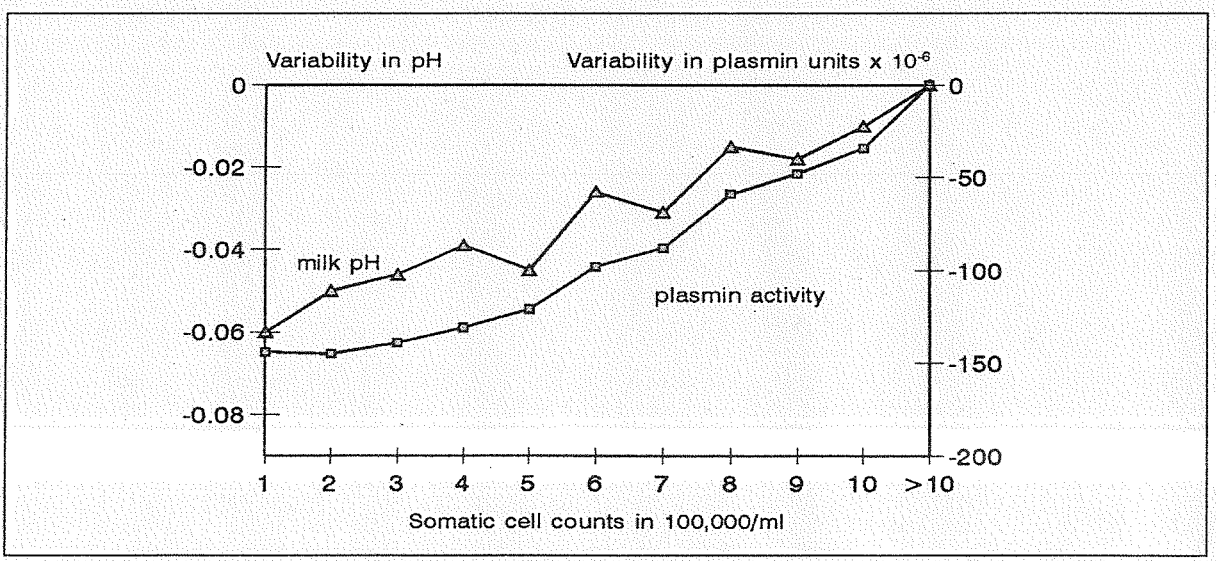

Fig. 5: Plasmin activity and pH of milk with different somatic cell counts (5)

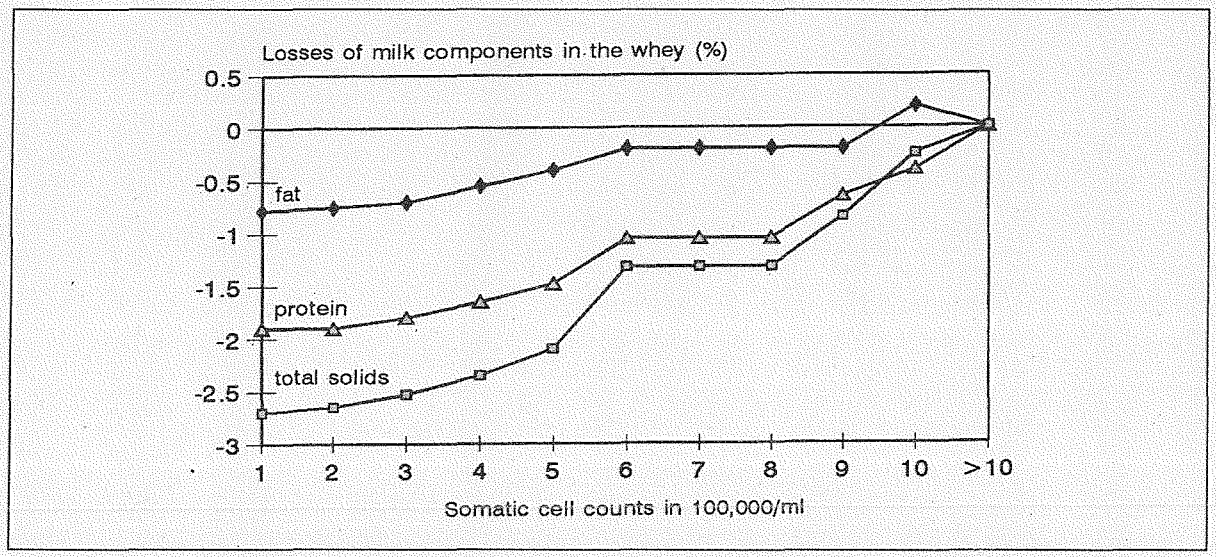

Fig. 6: Variation in losses of milk components in whey for different somatic cell count (5)

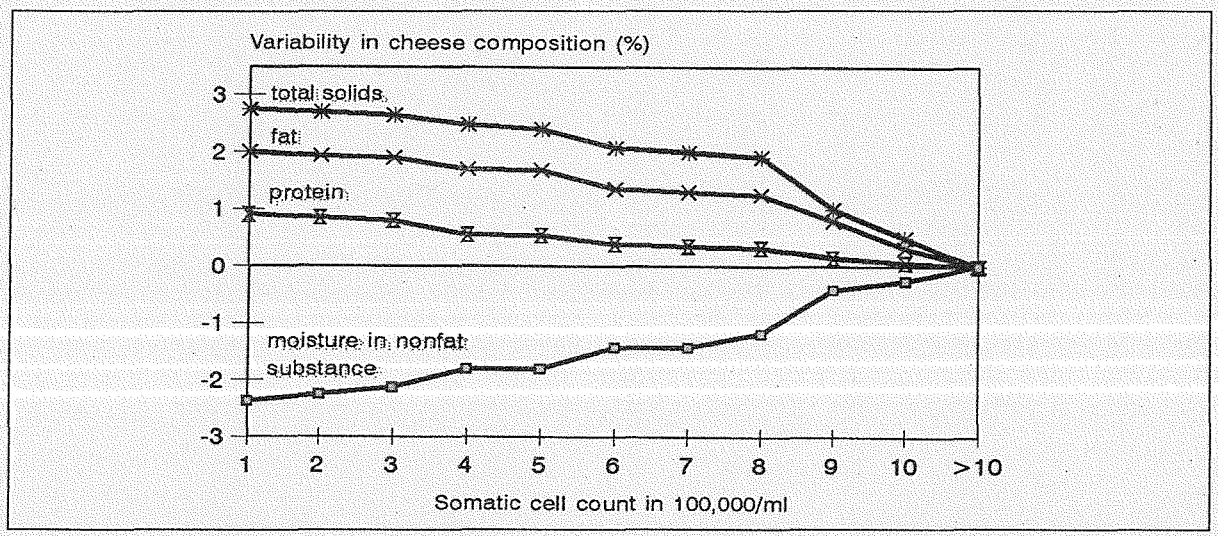

Fig. 7: Effect of somatic cell count level on cheese content of total solids, fat protein and moisture in nonfat substance (5)

The changes described above could affect the sensoric properties of milk and milk products, as given in Table 2 (6).

Tab. 2: Effect of Mastitis on Milk and Milk Products

Substrate	Alterations
Raw milk	Development of a rancid flavor; lower heat stability of whey proteins
Pasteurized milk	Reduction of flavor and quality
Recombined concentrated milk	Less stabile products
Cheese	Reduced starter activity; changed clotting time; reduction of curd firmness;losses of fat and casein with the whey; lower yield
Butter	Impairment of flavor; less flavor; oxidative taste; longer churning time; inhibition of diacetyl production

3. Mastitis: Aspects of hygiene

Pathogenic microorganisms

A number of diseases caused by pathogenic microorganisms is transmissible to men through milk (7).

The milk animal is a principal source of infection for a number of microorganisms, and some of these organisms are involved in the ethiology of mastitis (e.g. *Staphylococcus aureus, Escherichia coli*, Streptococci).

Staph. aureus is worldwide the most frequent source of food intoxications. Therefore the question arises, if *Staph. aureus* as a mastitis pathogen can form enterotoxins which might be a hazard for human beings. An intoxication of humans requires about 10^5–10^7 microorganisms per g or ml and an amount of toxins between 1–20 µg/person. In the EU Hygiene Directive 92/46 (8) standards for *Staph. aureus* are given for raw milk for the manufacturing of raw milk products (m = 500/ml; M = 2,000/ml). Moreover, standards are given for cheese from raw milk (m = 1,000/g; M = 10,000/g). Own investigations (9) during the last 2 years have shown that the number of *Staph. aureus* in raw milk could exceed in 20 % and more the EU standards, even if the total counts are far lower than 100,000/ml. The percentage of potential toxin producers could reach 20 % and more. This does not mean that *Staph. aureus* enterotoxins must be present in the milk. But the potential for the formation of enterotoxins under certain hygienic conditions for the manufacturing of raw milk products and therefore a risk for human beings cannot be excluded.

The occurrence of *Escherichia coli* in raw milk and raw milk products is still under discussion concerning possible risks for human beings (10). Investigations about 20 years ago have shown that the occurrence of streptococci of the serological group B could be a risk for humans (infections with group B streptococci) (11).

Even if pathogenic microorganisms, so far as mastitis pathogens are concerned, might not be of primary significance under human health aspects, the occurrence of these microorganisms could play a major role in relation to the marketing of raw milk and raw milk products as it is under discussion in the European countries and worldwide (3).

Residues in milk due to measures of mastitis therapy and mastitis prophylaxis

Antibiotics and sulfa drugs

The use of antibiotics for the treatment of mastitis is and will be in the future a major tool to control mastitis. The use of antibiotics intramammarily or parenterally leads to residues, which have to be evaluated under aspects of technology and consumer protection. Therefore the significance of antibiotic residues in milk has to be discussed under two important aspects:

- that relating to payment for milk on the basis of quality and
- that relating to public health and governed by food laws.

From a technicological point of view the sensitivity of thermophilic and mesophilic starters to different antibiotics might vary widely (Table 3).

For the protection of the consumer maximum residue limits (MRLs) or "safe levels" have been set (12). One of the main problems presently is the difference between detection limits of so-called inhibitor tests (microbial inhibitor tests) and the requirements due to the MRL or the safe limit concept in the EU or the US. Milk containing antibiotics must be excluded from human consumption, whereas milk containing "inhibitors" is penalized in many countries by a price reduction system. As an example the system developed in Germany is summarized in Figure 8 (13, 14).

Tab. 3: Sensitivity of thermophilic and meso-philicstarters to different antibiotics (µg/kg = ppb)

Antibiotic	Sensitivity of starters	
	Thermophilic [1]	Mesophilic [2]
Penicillin	4 – 10	5 – 10
Tetracyclin	300 – 500	500 – 200
Streptomycin	500 – 5000	500 – 1000
Chloramphenicol	500 – 1000	200 – 300
Spiramycin	300 – 500	2000 – 4000

[1] different Streptococcus thermophilus strains tested

[2] single strains of Lactococcus lactis/cremoris and diacetylactis and three mixed cultures (DL) tested

The methods available for the detection of antibiotics and sulfa drugs are summarized in the IDF Bulletin No 258/1991 (14). A possible system for the detection of inhibitors, antibiotics and sulfa drugs in raw milk and heat-treated milk according to European regulations is given in Figure 9 (13).

The use of different methods in different countries requires the development of test kit performance testing programmes to ensure the detection of concentrations of residues below the MRLs or the safe levels.

The different performances of tests used worldwide for the detection of antibiotics and sulfa drugs is given as an example in Figure 10, showing that the MRL for tetracycline is detected only by certain tests (15).

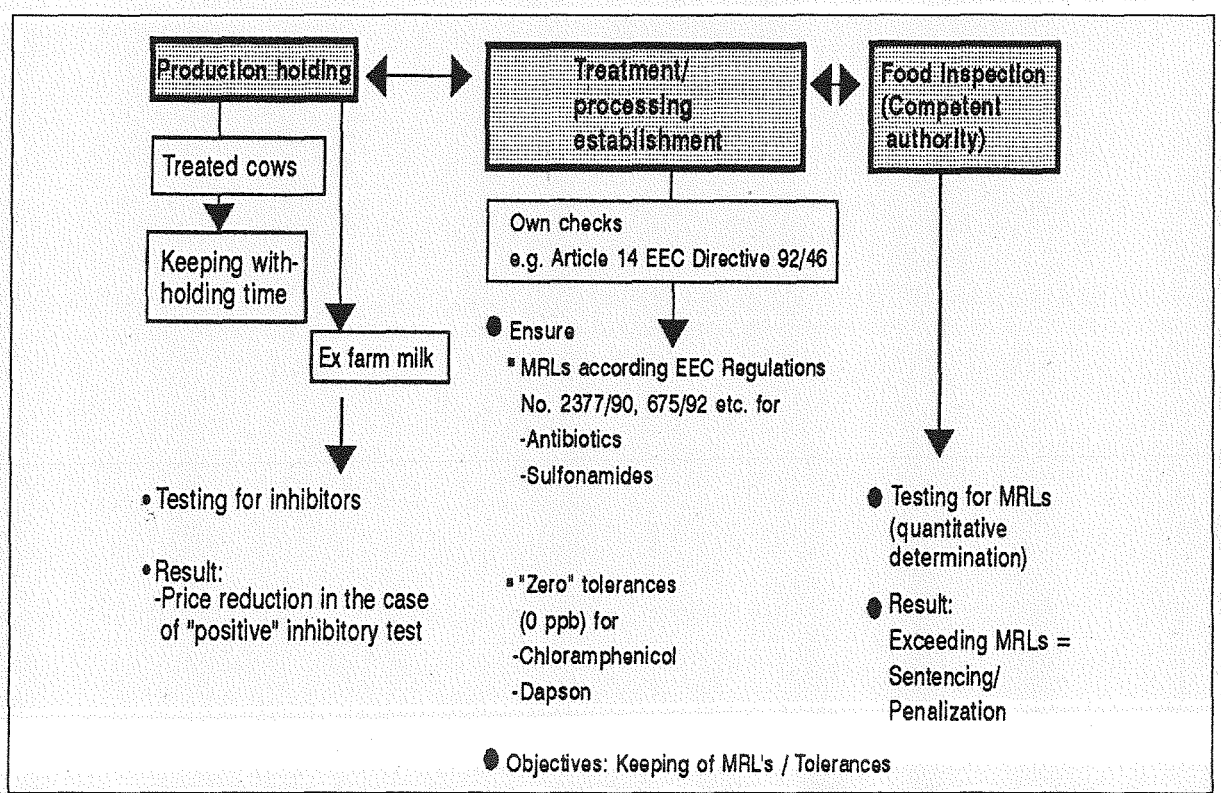

Fig. 8: Inhibitors, Antibiotics and Sulfonamides in Milk - Shared Responsibilities wihin an integrated system -

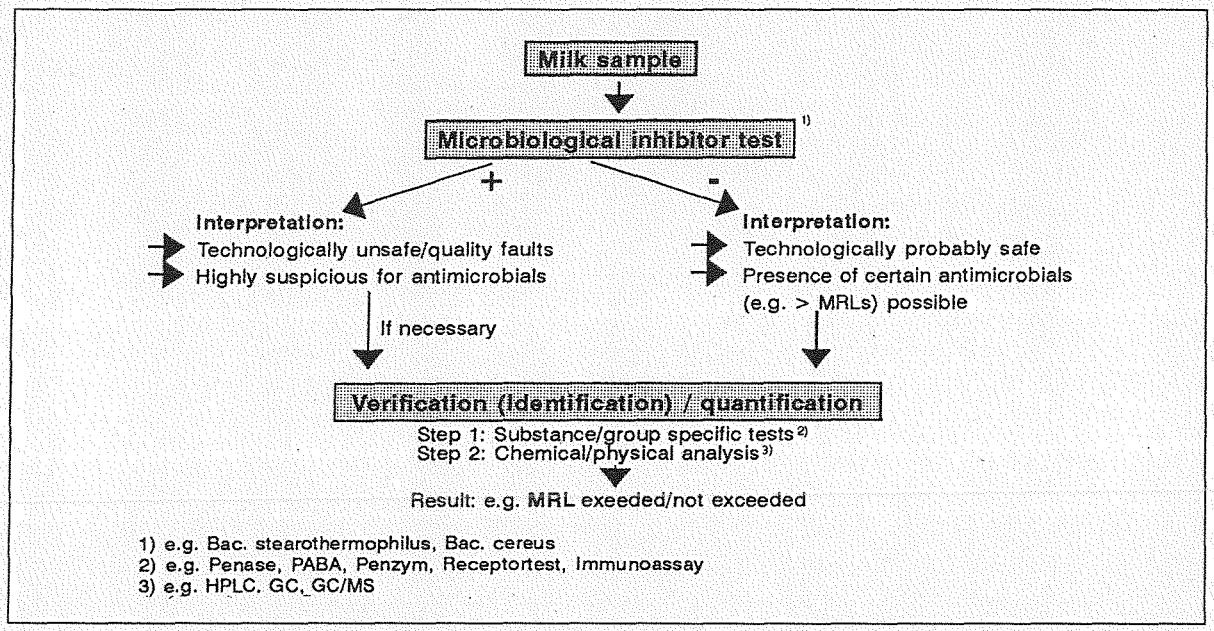

Fig. 9: Antibiotics, sulfa drugs and inhibitors in raw and heat treated milk - an intregrated detection system -

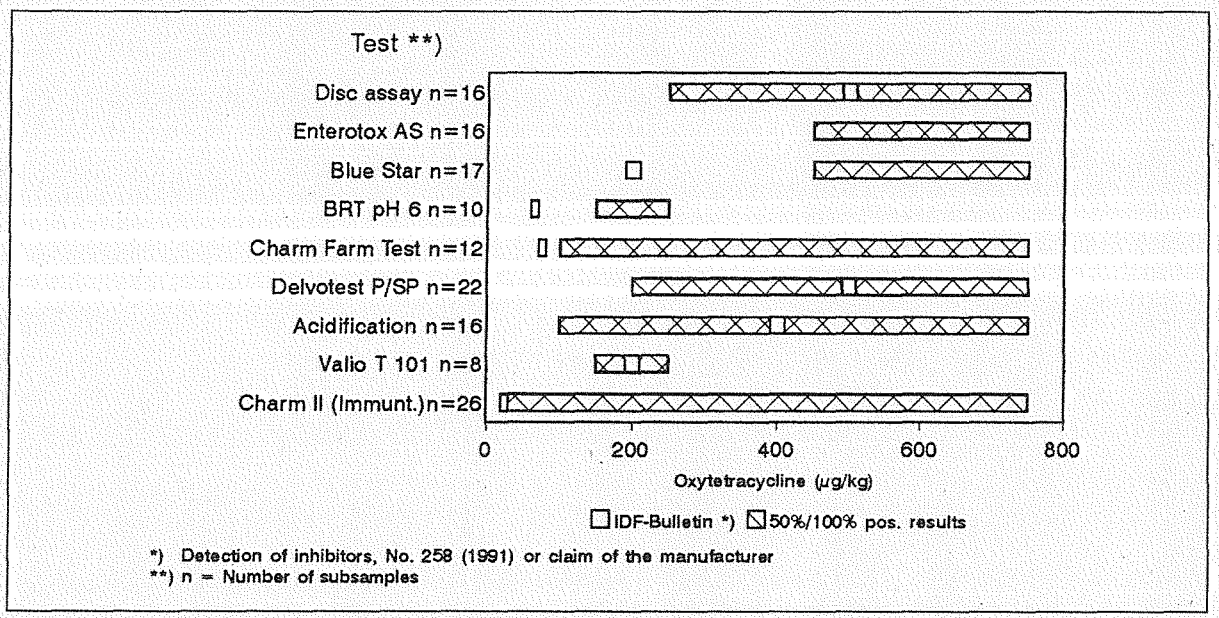

Fig. 10: IFD - Intercomparison 1992 - Oxytetracycline. Detection limits (µg/kg) of various methods

The sources of contamination for antibiotics and sulfa drugs in raw milk are summarized in Table 4 (16).

Even if this summary cannot be generalized for the conditions in all the countries worldwide it gives evidence that the post-secretory contamination should not be underestimated and that in some cases the withholding period might not be sufficient long to avoid the contamination of the milk.

Recent approaches to develop tests for individual cows should not be supported as the only idea of this approach would be to shorten the withholding period. Individual cow tests could only be justified in cases where the antibiotic used is well-known and the test has a detection limit below the MRLs or safe levels. Only in such a case a negative test could justify the delivery of the milk, even if a certain risk of contamination remains.

Tab. 4: Antibiotics and sulfonamides in raw milk – Contamination –

Secretory contamination	(%)	**Postsecretory** contamination	(%)
Total	41	Total	59
- Waiting period not regarded			
- No knowledge			
- Errors with milking		- Sequence of milking not regarded	29.7
- Errors with treatment			
- Milking of cows with dry-cow-therapy	35.5		
- Withholding period kept; but antibiotic excretion longer than waiting time	3.1		
		- Insufficient cleaning of milking equipment	29.3
- Errors of veterinarians	1.4		

From Schällibaum (1990)

Teat disinfection

The use of disinfectants for dipping of teats before and after milking must critically be evaluated under aspects of efficacy and residue formation. Not only the active ingredients as iodine, chlorhexidine, chlordioxide etc. have to be taken into consideration, but also other components used (e.g. detergents and additives). For the evaluation of these compounds the same principles as for other residues and contaminants have to be applied to calculate the non-effect-level, the acceptable daily intake and a maximum residue level (MRL) (Figure 11).

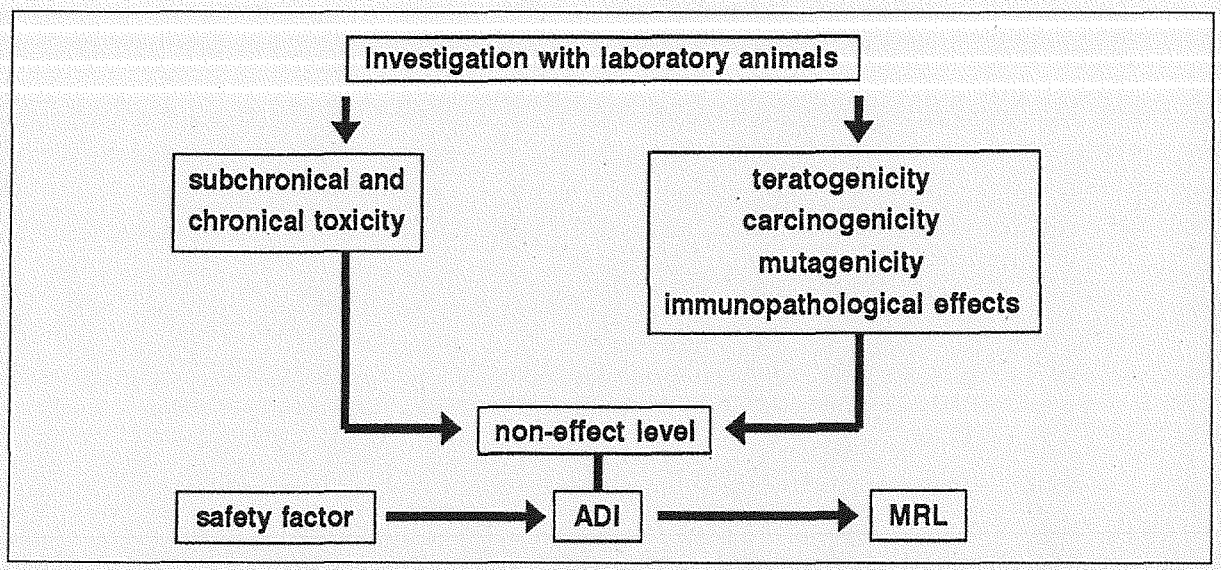

Fig. 11: Principles for the calculation of the acceptable daily intake (ADI) and maximum residue limits (MRLs)

As an example the detergent nonoxinol is given, which is used with different chemical structure in teat disinfectants. The number of ethylene oxide mols per mol nonylphenol may vary between 4 and 40. Structure of nonylphenols and an approach of evaluation/ assessment are given in Figure 12 and Table 5 (17).

The hygienic consequences from this chapter show clearly that residue aspects within concepts of mastitis control ("hygiene management") might play an important role for the hygienic value of the milk and for standards which must be kept within the national and international trade.

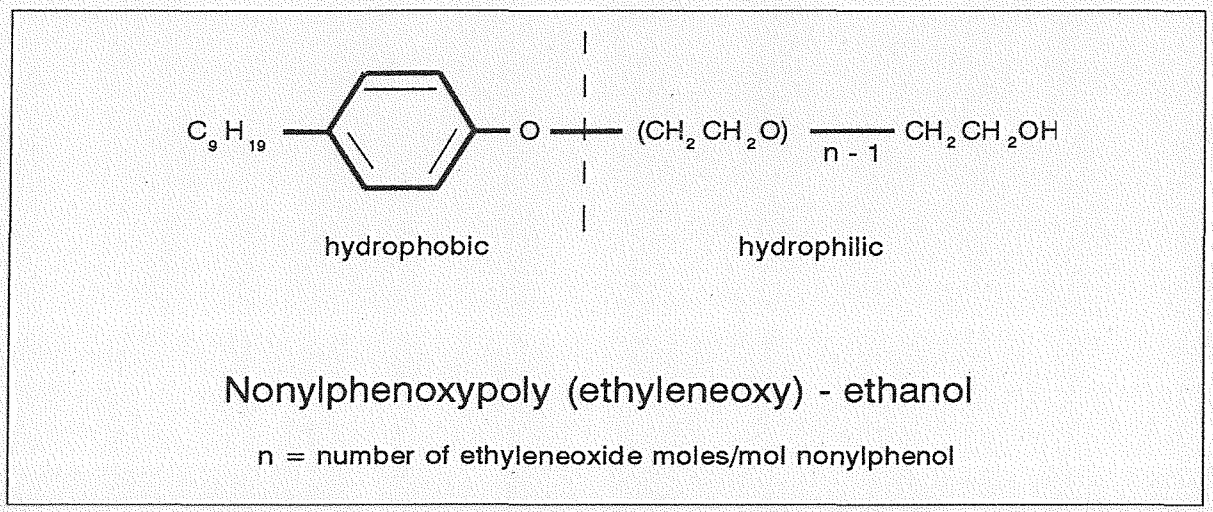

Fig. 12: Nonylphenoxypoly (ethyleneoxy)-ethanol (n= number of ethyleneoxide moles/mol nonylphenol)

Tab. 5: Nonoxinols – Evaluation / Assessment

NOEL	:	10-40 mg/kg
Toxicological effects	:	cardiotoxicity (necrosis of myocard)
ADI (Nonoxinol 9)	:	0.05 mg/kg body weight
MRL	:	2.3 mg/kg milk* without additional safety factor 0.9 mg/kg milk with additional safety factor 0.1 mg/kg milk for infant (5 kg)
Dog as basis for calculation	:	MRL lower by a factor of 3 or 4

* Intake: 1.5 kg

4. Somatic Cells: Indicator of milk quality and hygiene

The number of somatic cells is an indicator of the qualitative/hygienic properties of that milk and can reflect the mastitis situation in a given herd. The objectives of any measures of mastitis control should primarily cover the needs for milk with a low cell content, which meets the qualitative and hygienic expectations of manufacturers and consumers. The different aspects of concern require different threshold levels and different methods of calculation for the somatic cell count. Moreover, it has to be realized that the somatic cell content of the milk might be influenced by a number of factors as outlined in Table 6 and 7.

Even if we note today that the cell counts of healthy udder quarters are in the order of 100,000 or less we have to realize that this figure would not be a realistic goal for the herd bulk milk (Table 8) (13).

There is a continuous heterometrical change from the physiological (state) to the pathological state as it can be seen from Figure 13 (18).

This means under practical conditions that the target of diagnosis is decisive for positioning a cell count threshold. This holds for any degree of sampling origin: quarter, cow bulk milk or herd bulk milk. Given thresholds can not separate precisely different states of health, but just categories agreed upon with regard of different targets (Figure 14) (19).

Tab. 6: Influence on the somatic cell content of milk

1. Mastitis causing factors:
   - Pathogens
   - Toxins
   - Injuries
2. Physiological / pharmacological factors:
   - Stage of lactation
   - Breed
   - Veterinary drugs
3. Stress factors:
   - Change of feeding
   - Transport
   - Management

Tab. 7: Somatic cells in milk: Aspects of concern

1. Quality of the milk (changes of the compositional quality)
2. Hygiene (consumers acceptance, safety of milk, no trade barriers)
3. Mastitis control

For these objectives different threshold levels and different methods of calculation (geometric / arithmetic means) could be applicable.

Tab. 8: Somatic cell counts in the milk of healthy mammary glands

Samples	Cell count (1000/ml)	Evaluation parameter	Author(s)	(Year)
	< 100	Milk yield, milk components	Fox et al.	(1985)
	< 100	Milk yield	Jones et al.	(1984)
Quarter milk	> 20	–	Doggweiler & Hess	(1983)
samples	< 50	ACTH application	Paape et al.	(1979)
(foremilk)	< 100	Milk yield	Hess & Meyer	(1978)
	< 40	–	Paape & Schultze	(1974)
	< 20	Somatic cell pattern	Schalm	(1968)
	< 20	Histopathological tissue alterations	Chu	(1949)
Bulk milk				
samples	< 25	α-Lactalbumin in blood serum	McFadden et al.	(1988)
(total milking)	< 100	Somatic cell pattern	Baumgartner & Huber	(1971)

Within the discussion of the applicability of cell counts for the evaluation of the compositional and hygienic quality of the milk it has to be regarded that the cell counts may vary dependent on the level and influencing factors (Figure 15) (20).

Cell counts below 100,000/ml show very small changes even under "stress conditions". The higher the levels, the higher the numbers of somatic cells after the influence of a stress.

Similar experiences could be confirmed under the influence of a different stress factor, in this case the application of somatotropin (rBST) (21). The cellular reaction was again very small in cases where the original cell count level was very low, and higher reactions did occur in cases with increased cell count levels.

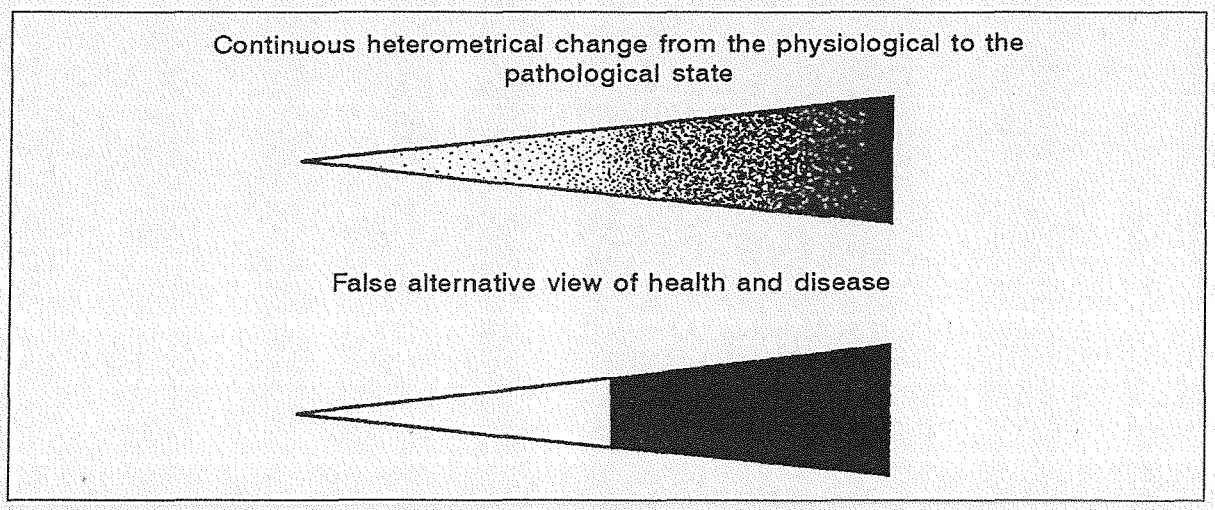

Fig. 13: The pathological (state, situation) does not occur by bounds but evolves continiously in terms of degree, time and position (site) from the physiological (Rössle, 1936; Schulz, 1991)

The number of somatic cells is presently the most widely applied parameter for the evaluation of quality and hygiene of milk and for the judgement of the mastitis situation within a herd.

It can clearly be stated that a number of somatic cells less than 400,000/ml will meet the requirements under qualitative and hygienic aspects. However, this cell count will not give an indication of a good udder health in the herd. Even with cell counts below 400,000/ml a number of clinical and subclinical cases in the herd might occur. This special situation has to be taken into consideration when discussing threshold values for somatic cells in milk on different levels.

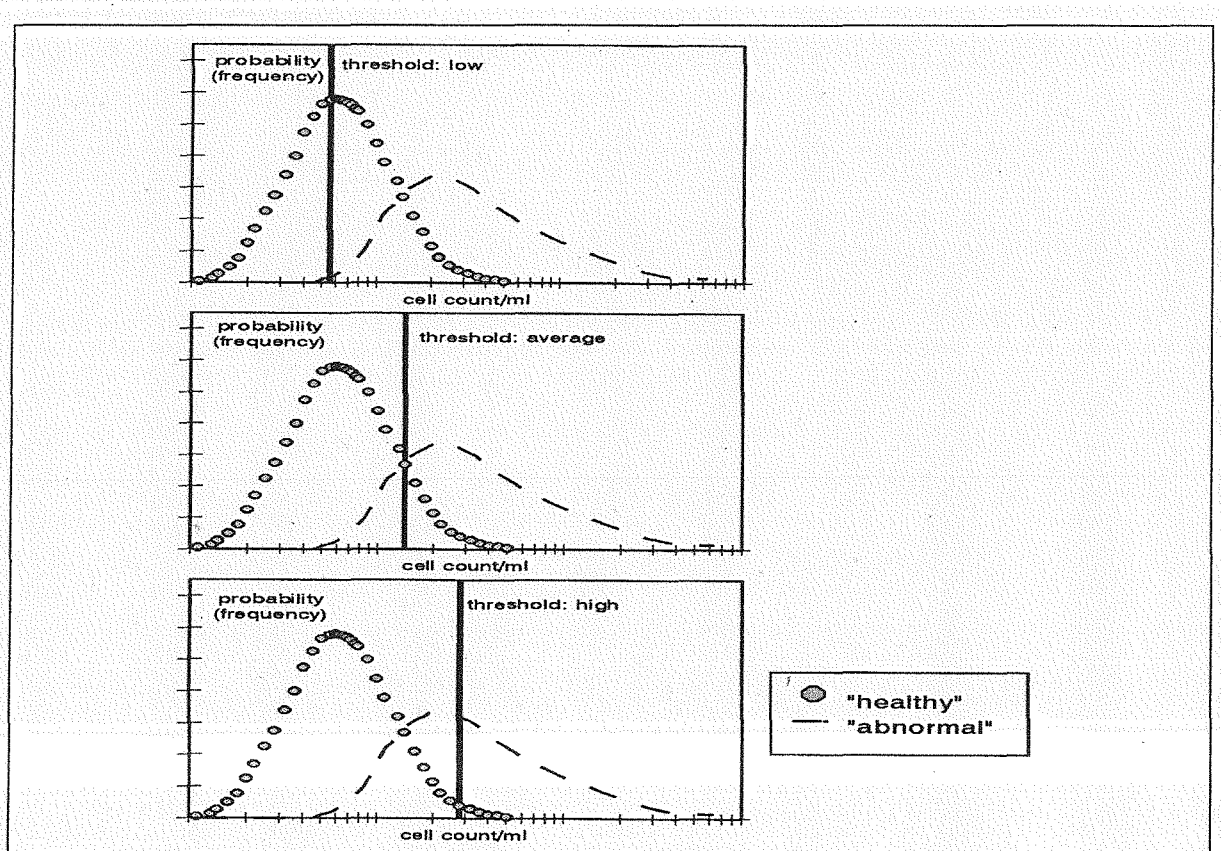

Fig. 14: Probability of wrong judgement in relation to the position of a threshold

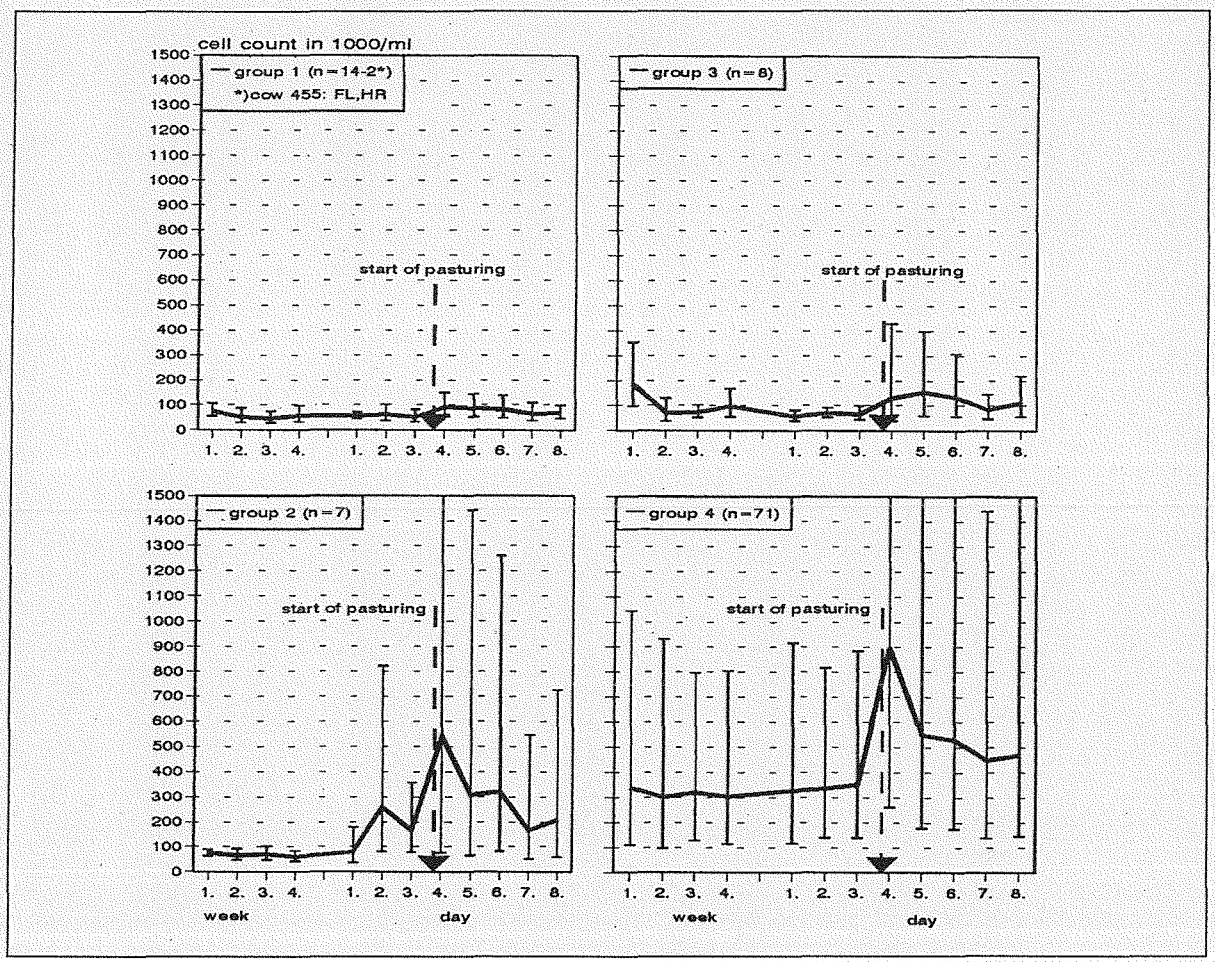

Fig. 15: Cell counts during trial with regard to groups of anamnesis (geom. mean and standard deviations)

5. Quality assurance and the system of hazard analysis critical control points (HACCP)

To reach and to maintain a high quality of milk and milk products a system of quality assurance has to be built up. The system of Hazard Analysis Critical Control Points (HACCP) is a pre-requirement for a high standard of quality and hygiene (Table 9), which is also applicable for the system "Mastitis control and somatic cells" (20).

Tab. 9: Hazard Analysis Critical Control Point (HACCP)

HACCP is a concept which permits a systematic approach to the identification and assessment of hazard and risks associated with the manufacture, distribution and use of a food product, as well as the definition of preventive measures for their control. **In this simplest form, HACCP consists of the following elements:**

- **Identification of hazards** and assessment of their severity and risk (hazard analysis)
- **Determination of critical control points** required to control identified hazards
- **Specification of critical limits** that indicate whether an operation is under control at a particular critical control point
- **Establishment and implementation of monitoring systems**
- **Execution of corrective actions** when critical limits are not met
- **Verification** of the system
- **Record keeping**

6. Future trends and outlook

The minimum requirements for the quality of raw milk can be summarized in a way that the compositional quality is given by minimum standards for protein (e.g. 2.8 %), total dry matter (e.g. 8.5 %), density (e.g. 1.028) and freezing point (e.g. –0.520°C). Additional parameters could be the casein content, lactic acid, free fatty acids (<1 meq/ KG), calcium and rennetability. How far genetic selection for certain genotypes (genetic polymorphism of milk proteins) might be justified, is still under discussion.

The minimum requirements for the hygienic quality of raw milk are summarized in Figure 16.

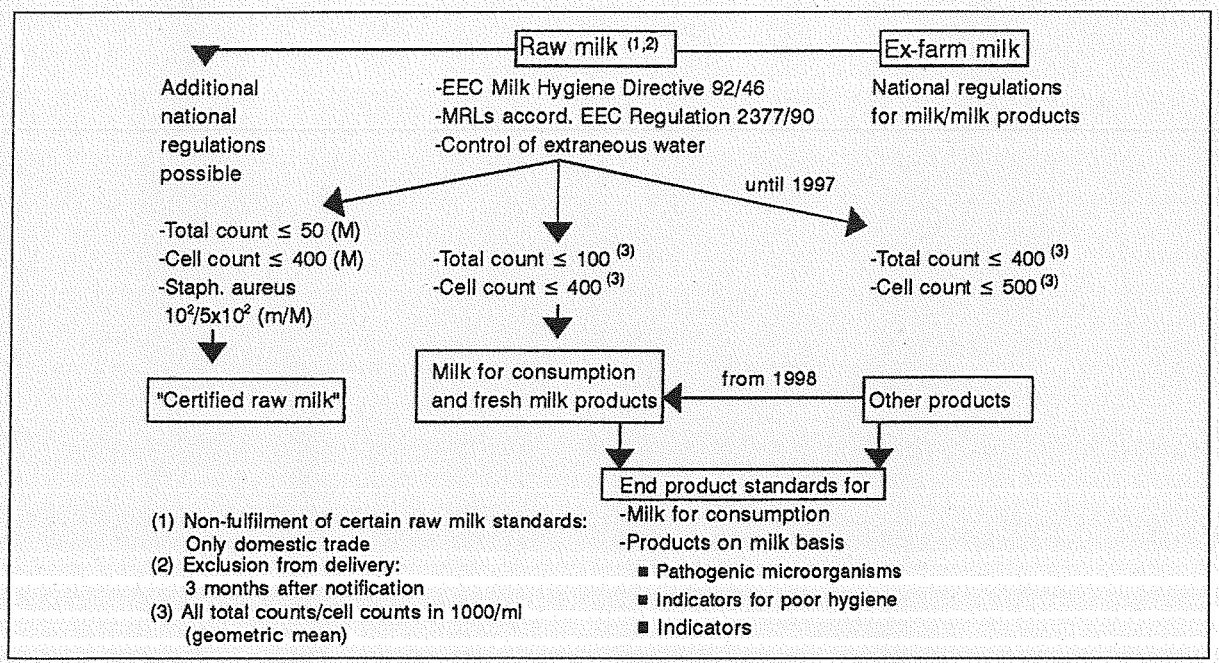

Fig. 16: Hygienic-qualitative requirements for raw milk, heat-treated milk and products on milk basis

This description is based mainly on the EEC Milk Hygiene Directive 92/46 (8). It summarizes the requirements and shows the ways how to reach safe products of high quality, which are fit for human consumption (wholesome), find the acceptance of the consumer and do not built up any trade barriers in the intra-community or international trade.

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8. Summary

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06 Mastitis (quality, hygiene)

1. Inflammatory changes in the mammary gland influence the process of milk synthesis both quantitatively and qualitatively. The changes in the constituents of milk affect the major components (lactose, fat, proteins) as well as fatty acids, protein fractions, caseins, whey proteins, anions and cations, conductivity, enzymes etc. With increasing numbers of somatic cells the growth of starter cultures in the milk may be adversely influenced. Renneting time and heat stability of the milk can be impaired.
2. The hygienic value of raw milk is determined by pathogenic microorganisms, saprophytic microorganisms, residues and contaminants. In the case of mastitis pathogenic microorganisms may occur, which are infectious also for men (e.g. *B-streptococci, Escherichia coli* strains) or which form under certain circumstances toxins (e.g. *Staphylococcus aureus*, *Escherichia coli*).
3. Residues due to the treatment of mastitis include primarily antimicrobials like antibiotics and sulfa drugs. The significance of antibiotic residues in milk has to be discussed under two important aspects:
   - that relating to payment of milk on the basis of the technological quality ("inhibi tors") and
   - that relating to public health and governed by food laws.
4. Concerning the effect of antibiotic residues on human health a number of aspects has to be considered (toxicological, microbiological and immunopathological effects). From a technological point of view the sensitivity of thermophilic and mesophilic

starters to different antibiotics may vary widely. The fixation of maximum residue limits (MRLs) for a number of antimicrobials has led to the difficulty that a negative result of so-called inhibitor tests does not neccessarily indicate concentrations of antimicrobials below the MRLs. A new and integrated system for the detection of antimicrobials has to be developed, which takes technological and toxicological aspects into concern.

5. The use of disinfectants for the dipping of teats before and after milking must also critically be evaluated. Not only the active ingredients (iodine, chlorhexidine, chlorine etc.) have to be taken into consideration, but also other components used (e.g. detergents, additives).
6. The number of somatic cells in milk is an indicator of its qualitative/hygienic properties, which case reflect the given mastitis situation in the herd. The objectives of mastitis control measures should primarily cover the supply of milk with a low somatic cell content, which meets the qualitative and hygienic expectations of manufacturers and consumers.

8. Zusammenfassung

Heeschen, W.H., Reichmuth, J.: **Mastitis: Aspekte von Milchqualität und Hygiene.** Kieler Milchwirtschaftliche Forschungsberichte **46** (3) 221-237 (1995)

06 Mastitis (Qualität, Hygiene)

1. Entzündliche Veränderungen in der Milchdrüse beeinflussen Beschaffenheit und Menge der gebildeten Milch. Die Änderungen in der Zusammensetzung betreffen sowohl die Hauptbestandteile (Laktose, Fett, Eiweiß) als auch Fettsäuren, Eiweißfraktionen, Kaseine, Molkenproteine, Anionen, Kationen, Leitfähigkeit, Enzyme usw. Mit steigendem somatischem Zellgehalt kann das Wachstum von Starterkulturen ungünstig beeinflußt werden. Die Lagerungszeit kann verlängert, die Hitzestabilität herabgesetzt sein.
2. Der hygienische Wert von Rohmilch wird bestimmt durch pathogene Mikroorganismen und Saprophyten sowie durch Rückstände und Verunreinigungen. Euterentzündungen werden hervorgerufen durch pathogene Mikroorganismen, von denen einige auch den Menschen infizieren können (z. B. Streptokokken der Gruppe B, Stämme von Escherichia coli), oder unter gewissen Umständen Toxine bilden (Staphylococcus aureus, Escherichia coli).
3. Rückstände aus der Behandlung von Euterentzündungen sind im wesentlichen Antibiotika und Sulfonamide. Die Bedeutung solcher Rückstände muß unter zwei Gesichtspunkten diskutiert werden:
   - der Bezahlung der Milch nach technologischer Qualität („Hemmstoffe") und
   - der Gesundheit der Verbraucher (Lebensmittelrecht).
4. Der Einfluß von Antibiotikarückständen auf die menschliche Gesundheit umfaßt toxikologische, mikrobiologische und immunopathologische Effekte. Die Empfindlichkeit thermophiler und mesophiler Starterkulturen kann in weiten Grenzen variieren. Die Festlegung von Obergrenzen für die Konzentration von Rückständen (MRL) hat zu dem Problem geführt, daß negative Ergebnisse sogenannter Hemmstofftests nicht notwendigerweise Konzentrationen von antimikrobiellen Substanzen ausweisen, die unterhalb der MRLs liegen. Es muß ein neues und integriertes System

für den Nachweis von antimikrobiellen Substanzen entwickelt werden, das technologische und toxikologische Aspekte berücksichtigt.

5. Der Einsatz von Desinfektionsmitteln für das Zitzentauchen vor und nach dem Melken muß ebenfalls kritisch untersucht und bewertet werden. Dabei müssen nicht nur die wirksamen Substanzen (Jod, Chlorhexidin, Chlor usw.) berücksichtigt werden, sondern auch die zusätzlich verwendeten Komponenten wie Detergentien und Zusatzstoffe.
6. Der Zellgehalt der Milch ist ein Indikator für deren qualitative/hygienische Eigenschaften, soweit sie sich aus der Eutergesundheit einer Herde ergeben. Alle Maßnahmen zur Bekämpfung der Mastitis sollten ausgerichtet sein auf die Produktion einer Milch mit niedrigem Zellgehalt, der die Erwartungen von Meiereien und Verbrauchern an Qualität und Hygiene erfüllt.

Rèsumè

Heeschen, W.H., Reichmuth, J.: **Mammite: la maladie sous les aspects de la qualité du lait et de la hygiène.** Kieler Milchwirtschaftliche Forschungsberichte **46** (3) 221-237 (1995)

06 Mammite (qualité, hygiène)

(1) Les changements inflammatoires dans la glande mammaire influencent le procès de la synthèse du lait des points de vue quantitatif et qualitatif. Les modifications dans les constituents du lait ont de l'effet sur les composants principaux (lactose, graisse, protéines) et de même que les acides gras, les fractions de protéine, les caséines, les séroprotéines, les anions et cations, la conductivité, les enzymes etc. Avec le nombre croissant de cellules somatiques la croissance des levains dans le lait peut être influencée de manière opposée. Le temps de coagulation et la stabilité du lait à la chaleur peuvent être détériorés.

(2) La valeur hygiénique du lait cru est déterminée par les microorganismes pathogènes et saprophytères, des résidus et les contaminants. En cas de mammite des microorganismes pathogènes peuvent apparaître qui sont infectieux aussi pour l'homme (p.ex. streptocoques B, *Escherichia coli*) ou qui à certaines conditions forment des toxines (p.ex. *Staphylococcus aureus, Escherichia coli).*

(3) Les résidus résultant du traitement de la mammite comprennent surtout des antimicrobiens comme des antibiotiques et des sulphonamides. Il faut discuter sur l'importance des résidus antibiotiques dans lait sous deux aspects importants

- celui du paiement du lait à la base de la qualité technologique („inhibiteurs") et
- celui concernant la santé publique et le régime des lois alimentaires.

(4) Concernant l'effet des résidus antibiotiques sur la santé humaine un nombre d'aspects doit être pris en considération (effets, toxicologiques, microbiologiques et immunopathologiques). Du point de vue technologique la sensibilité des levains thermophiles et mésophiles aux antibiotiques divers peut varier largement. L'établissement des limites maximum de résidus (MRLs) pour un nombre d'antimicrobiens a mené à la difficulté de que le résultat négatif d'un test "inhibiteur"

n'indique pas nécessairement des concentrations d'antimicrobiens au dessous les MRLs. Un nouveau système intégré pour la détermination d'antimicrobiens a été développé, qui tient compte des aspects technologiques et toxicologiques.

(5) L'emploi des désinfectants pour le trempage du trayon avant et après la traite doit être évaluée critiquement. Il faut prende en considération non seulement les ingrédients actifs (iode, chlorhexidine, chlorure etc.) mais aussi d'autres composants (p.ex. des détergents, des additifs).

(6) Le nombre de cellules somatiques dans le lait est un indicateur des caractéristiques qualitatifs et hygiéniques et reflètent la situation actuelle de la mammite dans le troupeau. Les mesures de contrôle de la mammite doivent avoir pour objet primairement de fournir un lait avec une teneur réduite en cellules somatiques selon les attentes des producteurs et des consommateurs des points de vue qualitatif et hygiénique.